



**ORANGE COUNTY  
MAXEY COMMUNITY CENTER – HVAC REPLACEMENT  
BID DOCUMENTS**

**FOR  
ORANGE COUNTY  
CAPITAL PROJECTS  
400 E. SOUTH STREET  
ORLANDO, FLORIDA 32801**

**BY  
MATERN PROFESSIONAL ENGINEERING, INC.  
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**JUNE 17, 2014**

**ORANGE COUNTY  
MAXEY COMMUNITY CENTER  
HVAC REPLACEMENT**

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SECTION 01010  
SUMMARY OF WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.
- B. When the titles such as Engineer, Project Engineer, or Owner are used throughout this specification, this implies Orange County as property owner and/or an officially appointed County Representative.

1.02 PROJECT DESCRIPTION

- A. Performance of all tasks specified in the contract documents shall be the responsibility of the contractor unless specified otherwise.

1.03 SCOPE OF WORK

- A. The work consists of the following:
  - 1. Remove one fifteen-ton and one twenty five-ton modular air handlers from the mezzanine located above the existing ceiling per the contract documents.
  - 2. Provide and install one new chilled water 15-ton and one 25-ton air handlers. The new AHU's will be located in the same location as the existing systems.
  - 3. The existing JCI BAS controls and line voltage will be reconnected to the new units.
  - 4. All new ductwork necessary to reconnect to the existing duct will be constructed of externally lined sheet metal.
  - 5. Remove two existing Trane air cooled condensers and install a new air cooled chiller in the same location as the existing outdoor units. The new chiller will be securely fastened to the existing concrete pad to meet local and state wind load requirements.
  - 6. The existing refrigerant lines will be removed. Provide new underground chilled water lines from the chiller yard to the mechanical mezzanine.
  - 7. Existing ducts shall be cleaned.
  - 8. Replace all VAV boxes, EDH-1, EF-3, and EF-4 within the building. Relocate all VAV boxes to the mezzanine.
  - 9. Electrical work associated with the replacement of these units.
  - 10. Provide Test & Balance of all systems in the entire building.

1.04 CONTRACTOR RESPONSIBILITIES

- A. General:
  - 1. The contractor shall have all submittals approved by the Engineer and accepted by the Owner prior to the start of active construction.
  - 2. The contractor shall have all equipment and material onsite prior to the start of active construction.
  - 3. The contractor shall submit to the Owner prior to the project pre-construction meeting the following:
    - Schedule of Values
    - Construction Schedule

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- Submittal Schedule
  - Emergency Telephone List including subcontractors and suppliers
4. The contractor shall field verify existing conditions of construction prior to start of active construction.
  5. The contractor shall coordinate with the Owner on the operation of the existing fire alarm system prior to the start of active construction. There shall be an action plan for the operation of the fire alarm system during construction submitted by the contractor to the Owner for acceptance. This action plan shall be in place prior to the start of active construction. Any false fire alarms that occur during construction and deemed by the Owner to be the fault of the contractor, the contractor shall pay all costs incurred from the local fire department for responding to a false alarm.
  6. The contractor is responsible for moving furniture and or equipment if necessary to perform the work included in the contract. The contractor is responsible for placing the furniture and or equipment back in its original location. The contractor is responsible for any damages to furniture, equipment, etc., which occur during construction. The contractor shall provide protection for floors, walls, furniture, equipment and any other items that may be subject to damage during the construction periods.
  7. The contractor shall coordinate with the Owner on the operation of the security alarm system prior to the start of active construction. The contractor shall submit an action plan for operation of the security alarm system during construction to the Owner for acceptance prior to start of active construction. This active plan shall be in place prior to the start of active construction. Any false security alarms that occur during construction and deemed by the Owner to be the fault of the contractor, the contractor shall pay all cost incurred from the local police and or sheriff department for responding to a false alarm.
  8. The contractor shall videotape or take pictures of pre-existing conditions of the interior and exterior of the building prior to the start of active construction. Failure to provide photographs or videotape prior to start of construction, places the responsibility on the Contractor to complete the necessary replacement, repairs, and or cleaning as determined by the Owner at no additional cost to the Owner. One set of photographs (in a three-ring binder) or videotape of the site existing conditions shall be submitted to the Owner.
  9. The contractor shall at all times maintain daily cleanup of construction areas. Work areas that are not cleaned by the contractor, and cleaned by the Owner, those costs shall be charged back to the contractor via change order.
  10. The contractor shall provide a construction schedule to the Owner's Project Manager prior to the pre-construction meeting. The contractor shall update the construction schedule weekly and submit it to the Owner's Project Manager for review.

1.05 WORK UNDER OTHER CONTRACTS

- A. Separate contracts may be issued to perform certain construction operations at the site.

1.06 WORK SEQUENCE

- A. The facility shall remain fully occupied and operational while work is in progress. All indoor work shall be performed during normal business hours. Normal business hours are defined as 8am to 5pm. Material and equipment deliveries will be during normal business hours. Indoor work may be performed during normal working hours; work in other phases shall be performed after hours, unless authorized by Owner for daytime work. After hours is defined as 6pm to 6am Monday through Friday.
- B. The contractor may work on the weekends at his or her discretion. Weekend work shall

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not be an additional cost to the Owner. The contractor will coordinate with the Owner for access to the building on weekends and after hours work.

1.07 CONTRACTOR USE OF PREMISES

- A. General: During the construction period, the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises is limited only by the Owner's right to perform construction operations with its own forces or to employ separate contractors on portions of the project.
- B. General: Limited use of the premises to construction activities in areas indicated within the limit of the premises. The Contractor may use any portion of the site for storage or work areas or any legal purpose.
  - 1. Confine operations to areas within Contract limits indicated on the Drawings. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.
  - 2. Keep driveways and entrances serving the premises clear and available to the Owner and the Owners' employees at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
  - 3. Burial of Waste Materials: Do not dispose of organic and hazardous material on site, either by burial or by burning.
  - 4. Where appropriate, maintain the existing building in a watertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.
  - 5. Confine construction operations to the areas permitted by the contract documents and other Owner directives.
  - 6. Provide protection and safekeeping of material and equipment stored on premises.
  - 7. Contractor will move any stored material and equipment, which interfere with operations of the Owner or other contractors.
  - 8. Comply with Owners' requirements for ingress and egress procedures, prohibitions against firearms, procedures for transportation of workers, safety and fire prevention requirements and pollution control requirements.
  - 9. Contractor to require all employees and subcontractors to wear non-objectionable clothing; prohibit revealing clothing and articles of clothing with offensive writings displayed. The contractor shall require offending personnel to leave the premises until such clothing is changed.
  - 10. Contractor employees and subcontractors will not fraternize with County employees or the general public during the entire construction period.
  - 11. Use of sound equipment (such as boom boxes, stereos, radios, etc.) during day times of construction is not allowed.
  - 12. Smoking is not allowed on County property.
  - 13. Conduct that is disrespectful, abusive or otherwise objectionable to the Owners' employees or general public will not be allowed at any time during the construction period. Repetitive complaints and violations of the requirements listed above will be cause for dismissal and or permanent removal of offending personnel from the project.
  - 14. Contractor to coordinate with the Owner the site location for storage of equipment, machinery, materials, tools and a construction waste dumpster.
  - 15. Contractor shall at all times keep the premises free of all waste or surplus materials, rubbish and debris, which is caused by contractor employees or subcontractors resulting from their work. Contractor shall maintain a safe work environment to all building occupants during the construction period.

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1.08 OWNER OCCUPANCY

- A. Owner Occupancy: The Owner will be occupying the building during construction. Normal occupancy hours are 7 AM to 6 PM Monday through Friday. The contractor is to coordinate with the Owner's representative for areas in the building that work can be performed on during normal business hours. Work performed after normal business hours can be done provided the area where work is done is fully operational and back in original condition prior to beginning of the next business day. Such placing of equipment and partial occupancy shall not constitute acceptance of the total work.
1. A Certificate of Substantial Completion will be executed for each specific portion of the Work to be occupied prior to Owner occupancy.
  2. Obtain a Certificate of Occupancy from local building officials prior to Owner occupancy.
  3. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy the Owner will provide operation and maintenance of mechanical and electrical systems in occupied portions of the building.

1.09 DISTRIBUTION OF RELATED DOCUMENTS

- A. The Contractor is solely responsible for the distribution of ALL related documents/drawings to ALL appropriate vendors/subcontractors to ensure proper coordination of all aspects of the project and its related parts during bidding and construction.

1.10 CONTRACT DOCUMENT FILE

- A. Copies of the Contract Documents, Plans, Specifications, Addenda, Change Orders, Engineers Supplemental Instructions, approved Shop Drawings, Substitution Acceptances, etc. shall be placed and maintained at the project site by the Contractor throughout the entire contract period. These said documents shall be filed in a manner that allows for ease of retrieval. Documents shall be made available to the Engineer and the County's representatives throughout this same period.

1.11 BUILDING/SITE SECURITY

- A. The building shall be secured from unwarranted entry at the end of each workday.
- B. Contractor Background Checks – Orange County will require each employee of the Contractor and his sub-contractors to perform a standard FDLE security background check to work within the Orange County Facilities premises, except those located at Corrections Complex. Results shall be submitted to Orange County Facilities Management Division prior to any individual being approved and allowed in the building. The cost of this check is the responsibility of the Contractor.

PART 2 - PRODUCTS

2.01 ASBESTOS FREE MATERIAL

- A. Contractor shall provide a written and notarized statement on company letterhead(s) to certify and warrant that ONLY ASBESTOS FREE MATERIALS AND PRODUCTS were provided as required by the Engineer in Section 01400, QUALITY CONTROL. Such statement shall be submitted with the final payment request. Final payment shall not be made until such statement is submitted. Contractor agrees that if materials containing asbestos are subsequently discovered at any future time to have been included in the

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construction, the Contractor shall be liable for all costs related to the redesign or modification of the construction of the project so that materials containing asbestos are removed from the facility. If construction has begun or has been completed pursuant to a design that includes asbestos containing materials, the Contractor shall also be liable for all costs related to the abatement of such asbestos.

PART 3 EXECUTION (Not applicable).

END OF SECTION 01010



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SECTION 01027  
APPLICATION FOR PAYMENT

PART I - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.
- B. The Contractor's Construction Schedule and Submittal Schedule are included in Section 01300 – "SUBMITTALS".

1.03 SCHEDULE OF VALUES

- A. Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
  - 1. Submit the Schedule of Values to the Owner at the earliest feasible date, but in no case later than Preconstruction Meeting.
  - 2. Sub-Schedules: Where the Work is separated into phases that require separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
- B. Format and Content: Use the Project Manual Table of Contents as a guide to establish the format for the Schedule of Values.
  - 1. Identification: Include the following project identification on the Schedule of Values:
    - a. Project name and location.
    - b. Name of the Engineer
    - c. Project Number
    - d. Contractor's name and address
    - e. Date of submittal
  - 2. Arrange the Schedule of Values in a tabular form with separate columns to indicate the following for each item listed:
    - a. Generic name
    - b. Related Specification Section
    - c. Change Orders (numbers) that have affected value
    - d. Dollar Value
    - e. Percentage of Contract Sum to the nearest one-hundredth percent, adjusted to total 100 percent
  - 3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Break principal subcontract amounts down into several line items:

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- a. A value will be given for at least every major specification section (subsections can logically be grouped together).
  - b. A single material subcontractor will not be required to be broken down into labor and material unless it is anticipated the materials will be stored and invoiced prior to installation.
  - c. All multiple item subcontracts or work items (i.e. mechanical, electrical items, etc.) will be shown broken down at least in labor and material (all taxes, burden and overhead and profit included).
  - d. Mobilization (move-on, bond, insurance, temporary office and sanitary service installation) shall not exceed 2 1/2% of contract price.
  - e. For multi-story work all items broken down per floor.
  - f. HVAC: Typically shown per specification section, labor and material, per floor.
  - g. Electrical: same as HVAC.
  - h. Logical grouping of specification subsections are permitted.
4. Round amounts off the nearest whole dollar, the total shall equal the Contract Sum.
  5. For each part of the Work where an Application for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
  6. Margins of Cost: Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.
    - a. At the Contractor's option, temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown as separate line items in the Schedule of Values or distributed as general overhead expense.
  7. Schedule Updating: Update and resubmit the Schedule of Values when Change Orders or Construction Change Directives result in a change in the contract sum.

1.04 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as reviewed by the Owner's representative and paid for by the Owner.
  1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the Final Application for Payment involve additional requirements. See items G, I, J and K of this section.
- B. Payment Application Times: The period of construction work covered by each Application of Payment is the period indicated in the Agreement.
- C. Payment Application Forms: Use the County's most updated form as the form for Application for Payment. Form given at the Preconstruction Conference.
- D. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Owner. Incomplete applications will be returned without action.

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1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made.
  2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.
- E. Transmittal: Submit four (4) original executed copies of each Application for Payment to the Project Manager by means ensuring receipt within 24 hours; one copy shall be complete, including waivers of lien and similar attachments, when required.
1. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Project Manager.
- F. Waivers of Mechanics Lien: With each Application for Payment submit waivers of mechanics liens from subcontractors of sub-subcontractors and suppliers for the construction period covered by the previous application.
1. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.
  2. When an application shows completion of an item, submit final or full waivers.
  3. The Owner reserves the right to designate which entities involved in the work must submit waivers.
  4. List all Subcontractor's start and finish dates to substantiate any Notice to Owner received by the Project Manager.
- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
1. List of principal subcontractors
  2. List of principal suppliers and fabricators
  3. Schedule of Values
  4. Approved Contractor's Construction Schedule (preliminary if not final)
  5. Schedule of principal products
  6. Schedule of unit prices (if applicable)
  7. Submittal schedule (preliminary if not final)
  8. List of Contractor's staff assignments
  9. List of Contractor's principal consultants
  10. Copies of building permits for trades requiring separate permits
  11. Copies of authorizations and licenses from governing authorities for performance of the Work
  12. Initial progress report
  13. Report of Pre-construction Meeting
  14. Initial settlement survey and damage report, (if required)
  15. Listing of all long lead procurement items monthly applications for payment will be accompanied with updated schedule and review of as-built drawings
- H. Interim Application for Payment: Payment will be processed once a month. No applications will be processed without receipt of previous months waiver of lien described in subsection F above. Payment for item will be based on percentage completed as determined and approved by the County Project Manager or invoice for stored materials. Retainage (10%) will be held for all interim applications.
- I. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for Owner

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occupancy of designated portions of the Work. Application shall also include all items listed in Part H. above.

J. Administrative actions and submittals that shall proceed or coincide with Substantial Completion Payment. Substantial Completion as defined per General Conditions Section "F" application include:

1. Occupancy permits and similar approvals
2. Warranties (guarantees) and maintenance agreements
3. Test/adjust/balance records
4. Maintenance instructions
5. Start-up performance reports
6. Change-over information related to Owner's occupancy, use, operation and maintenance
7. Final cleaning
8. Application for reduction of retainage, and consent of surety
9. List of incomplete Work, recognized as exceptions to Project Manager's Certificate of Substantial Completion

K. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment. Application for Payment includes the following:

1. Completion of Project Close-Out requirements
2. Completion of items specified for completion after Substantial Completion
3. Assurance that unsettled claims will be settled
4. Assurance that all work has been completed and accepted
5. Proof that taxes, fees and similar obligations have been paid
6. Removal of temporary facilities and services
7. Removal of surplus materials, rubbish and similar elements
8. Change of door locks to Owner's access
9. Submission of all close-out documents. Refer to Section 01700.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION 01027

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SECTION 01035  
MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. This section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 1 Section 01300 Submittals for requirements for the Contractor's Construction Schedule.
  - 2. Division 1 Section 01027 Application for Payment for administrative procedures governing applications for payment.
  - 3. Division 1 Section 01631 Product Substitutions for administrative procedures for handling requests for substitutions made after award of the Contract.

1.03 MINOR CHANGES IN THE WORK

- A. Supplemental instructions authorizing minor changes in the work, not involving an adjustment to the Contract Sum or Contract Time, will be issued by the Project Manager.

1.04 CHANGE ORDER PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Proposed changes in the work that will require adjustment to the Contract Sum or Contract Time will be issued by the Project Manager, with a detailed description of the proposed change and supplemental or revised Drawings and Specifications, if necessary.
  - 1. Proposal requests issued by the Project Manager are for information only. Do not consider them instruction either to stop work in progress, or to execute the proposed change.
  - 2. Unless otherwise indicated in the proposal request, within 7 days of receipt of the proposal request, submit to the Project Manager from the Owner's review, an estimate of cost necessary to execute the proposed change.
    - a. Include a list of quantities of products to be purchased and unit costs, along with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include a statement indicating the effect the proposed change in the work will have on the Contract Time.
    - d. Contractor and subcontractors will provide a complete detailed labor and material breakdown to justify change order request amount.
- B. Contractor-Initiated Change Order Proposal Requests: When latent or other unforeseen conditions in mutual accord with the Owner Representatives findings require

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modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Engineer.

1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
  2. Include a list of quantities of products to be purchased and unit costs along with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
  3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
  4. Comply with requirements in Section 01631 "Product Substitutions" - if the proposed change in the work requires that substitution of one product or system for a product or system not specified.
  5. Contractor and subcontractors will provide a complete detailed labor and material breakdown to justify change order request amounts.
- C. Proposal Request Form: Project Manager will transfer the information to the appropriate forms for approval. Use AIA Document G 709 for Change Order Proposal Requests.
- D. Proposal Request Form: If applicable, use forms provided by the Owner for Change Order Proposals.

1.05 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: When the Owner and Contractor are not in total agreement on the terms of a Change Order Proposal Request, the Project Manager may issue a Construction Change Directive instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. The Construction Change Directive will contain a complete description of the change in the Work and designate the method to be followed to determine change in the Contract Sum or Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
1. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.06 CHANGE ORDER PROCEDURES

- A. Upon the Owner's approval of a Change Order Proposal Request, the Project Manager will issue a Change Order for signatures of the Owner and Contractor on County's Change Order form, as provided in the Conditions of the Contract.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION 01035

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SECTION 01040  
PROJECT COORDINATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies administrative and supervisory requirements necessary for project coordination including, but not necessarily limited to:
  - 1. Coordination
  - 2. Administrative and supervisory personnel
  - 3. General installation provisions
  - 4. Cleaning and protection
- B. Progress meetings, coordination meetings and Pre-installation conferences are included in Section 01200 "Project Meetings".
- C. Requirements for the Contractor's Construction Schedule are included in Section 01300 "Submittals".

1.03 COORDINATION

- A. Coordination: Coordinate construction activities included under various Sections of these Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections of the Specification that are dependent upon each other for proper installation, connection, and operation.
  - 1. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results.
  - 2. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required: notices, reports, and attendance at meetings.
  - 1. Prepare similar memoranda for the Owner and separate Contractors where coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Preparation of Schedules
  - 2. Installation and removal of temporary facilities
  - 3. Delivery and processing of submittals
  - 4. Progress meetings
  - 5. Project close-out activities

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- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
  - 1. Salvage materials and equipment (if any) involved in performance of, but not actually incorporated in, the Work.
- E. Lack of coordination as specified in this and other sections of the contract documents are in grounds for assessment of back charges and/or termination in order to remediate the situation.

1.04 SUBMITTALS

- A. Coordination Drawings: Prepare and submit coordination Drawings where close and careful coordination is required for installation of products and materials fabricated off-site by separate entities, and where limited space availability necessitates maximum utilization of space for efficient installation of different components.
  - 1. Show the interrelationship of components shown on separate Shop Drawings.
  - 2. Indicate required installation sequences.
  - 3. Comply with requirements contained in Section “Submittals”.
  - 4. Refer to Division-15 Section “Basic Mechanical Requirements,” and Division-16 Section “Basic Electrical Requirements” for specific coordination Drawing requirements for mechanical and electrical installations.
- B. Staff Names: At the Preconstruction Conference submit a list of the Contractor’s principal staff assignments, including the Superintendent and other personnel in attendance at the site; identify individuals, their duties and responsibilities; list their addresses and telephone numbers.
  - 1. Post copies of the list in the project meeting room, the temporary field office, and each temporary telephone.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 GENERAL INSTALLATION PROVISIONS

- A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Manufacturer’s Instructions: Comply with manufacturer’s installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.
- C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.
- D. Provide attachment and connection devices and methods necessary for securing work. Secure work true to line and level. Allow for expansion and building movement.
- E. Visual Effects: Provide uniform joint widths in exposed work. Arrange joints in exposed work to obtain the best visual effect. Refer questionable choices to Project Manager for final decision.
- F. Recheck measurements and dimensions, before starting each installation.



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- G. Install each component during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.
- H. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.
- I. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Project Manager for final decision.

3.02 CLEANING AND PROTECTION

- A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- B. Clean and maintain completed construction as directed by the Project Manager and as frequently as necessary to ensure its integrity and safety through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where the applicable, such exposures include, but are not limited to, the following:
  - 1. Excessive static or dynamic loading
  - 2. Excessively high or low temperatures
  - 3. Excessively high or low humidity
  - 4. Air contamination or pollution
  - 5. Water
  - 6. Solvents
  - 7. Chemicals
  - 8. Soiling, staining and corrosion
  - 9. Rodent and insect infestation
  - 10. Combustion
  - 11. Destructive testing
  - 12. Misalignment
  - 13. Excessive weathering
  - 14. Unprotected storage
  - 15. Improper shipping or handling
  - 16. Theft
  - 17. Vandalism

END OF SECTION 01040

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SECTION 01200  
PROJECT MEETINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies administrative and procedural requirements for project meetings including but not limited to:
  - 1. Pre-Construction Conference
  - 2. Pre-Installation Conference
  - 3. Coordination Meetings
  - 4. Progress Meetings
- B. Construction schedules are specified in Section 01300 Submittals.

1.03 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction conference and organizational meeting at the project site or other convenient location no later than 20 days after execution of the agreement and prior to commencement of construction activities. Conduct the meeting to review responsibilities and personnel assignments.
- B. Attends: The County's Representative, the Contractor and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the work.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
  - 1. Tentative construction schedule
  - 2. Critical Work sequencing and/coordinating
  - 3. Designation of responsible personnel
  - 4. Procedures for processing field decisions and Change Orders
  - 5. Procedures for processing Applications for Payment
  - 6. Distribution of Contract Documents
  - 7. Submittal of Shop Drawings, Product Data and Samples
  - 8. Preparation of record documents
  - 9. Use of the Premises
  - 10. Office, Work and storage areas
  - 11. Equipment deliveries and priorities
  - 12. Safety procedures
  - 13. First aid
  - 14. Security
  - 15. Housekeeping
  - 16. Working hours
- D. Contractor must submit at the time of the meeting at least the following items:
  - 1. Schedule of Values

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2. Listing of key personnel including project superintendent and subcontractors with their addresses, telephone numbers, and emergency telephone numbers.
3. Preliminary Construction Schedule
4. Submittal Schedule

1.04 PRE-INSTALLATION CONFERENCE

- A. Conduct a Pre-installation conference at the site before each construction activity that requires coordination with other construction. The Installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise at least 48 hours in advance the Project Manager of scheduled meeting dates.
  1. Review the progress of other construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for:
    - a. Contract Documents
    - b. Options
    - c. Related Change Orders
    - d. Purchases
    - e. Deliveries
    - f. Shop Drawings, Product Data and Quality Control Samples
    - g. Possible conflicts
    - h. Compatibility problems
    - i. Time schedules
    - j. Weather limitations
    - k. Manufacturer's recommendations
    - l. Comparability of materials
    - m. Acceptability of substrates
    - n. Temporary facilities
    - o. Space and access limitations
    - p. Governing regulations
    - q. Safety
    - r. Inspection and testing requirements
    - s. Required performance results
    - t. Recording requirements
    - u. Protection
  2. Record significant discussions and agreements and disagreements of each conference along with and approved schedule. Distribute the record of the meeting to everyone concerned promptly including the Owner and Engineer.
  3. Do not proceed if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.05 COORDINATION MEETINGS

- A. Conduct project coordination meeting at weekly intervals on day and time as established by the Project Manager or more frequently, if necessary convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings and special pre-installation meetings.
- B. Request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved, to include subcontractors and

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representatives.

- C. Contractor shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.06 PROGRESS MEETINGS

- A. Conduct progress meetings at the Project site at bimonthly intervals or more frequently if necessary as directed by the Project Manager. Notify the Owner at least 48 hours in advance of scheduled meeting time and dates. Coordinate dates of meetings with preparation of the payment request.
- B. Attendees: In addition to representatives of the Owner and Engineer, each subcontractor, supplier or other entity concerned with current progress of involved in planning, coordination or performance of future activities with the project and authorized to conclude matters relating to progress.
- C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the Project.
  - 1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time, ahead, or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
  - 2. Review the present and future needs of each entity present, including such items as:
    - a. Interface requirements
    - b. Time
    - c. Sequences
    - d. Deliveries
    - e. Off-site fabrication problems
    - f. Access
    - g. Site utilization
    - h. Temporary facilities and services
    - i. Hours of work
    - j. Hazards and risks
    - k. Housekeeping
    - l. Quality and work standards
    - m. Change Orders
    - n. Documentation of information for payment requests.
- D. Reporting: No later than 3 days after each progress meeting date, distribute copies of minutes of the meeting to each party present and to other parties who should have been present. Include a brief summary, in narrative form, or progress since the previous meeting and report.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION 01200

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SECTION 01300  
SUBMITTALS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including:

1. Contractor's Construction Schedule
2. Submittal Schedule
3. Daily Construction Reports
4. Shop Drawings
5. Product Data
6. Samples

- B. Administrative Submittals: Refer to other Division-1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:

1. Permits
2. Applications for Payment
3. Performance and Payment Bonds
4. Insurance Certificates
5. List of Subcontractors with start and finish dates (update as necessary)
6. Schedule of Values
7. Construction Schedule

- C. The Schedule of Values submittal is included in Section 01027 "Applications for Payment".

1.03 ELECTRONIC SUBMITTAL PROCEDURES

- A. General: Submittals shall be submitted electronically directly to the Engineer from the General/Mechanical/Electrical Contractor.

1. **All shop drawings and other submittals as specified herein, shall be submitted in electronic format.** All electronic CAD generated drawings shall be in Acrobat PDF format and all product data or other information shall be submitted in Acrobat PDF format. Coordinate with Engineer prior to submitting. All electronic submittals shall be posted to the Engineer's FTP site. Information regarding the username and password shall be distributed to all parties prior to the pre-construction meeting.

- B. Electronic copies of CAD drawings made from the Construction/Contract Documents will not be provided by Engineer without a written indemnification. Indemnification form will be provided by the Engineer at Pre-Construction Meeting to the General/Mechanical/Electrical Contractor upon written request.

- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

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1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  - 2.. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
    - a. The Project Manager reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
  3. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
    - a. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Project Manager will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
    - b. If an intermediate submittal is necessary, process the same as the initial submittal.
    - c. Allow two weeks for reprocessing each submittal.
    - d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  3. Include the following information on label for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
      - 2) Where multiple products are shown, highlight/circle or identify product intended to be used
    - i. Number and title of appropriate Specification Section.
    - j. Drawing number and detail references, as appropriate.
    - k. Location(s) where product is to be installed, as appropriate.
    - l. Other necessary identification.

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- E. Substitution request to specified products will be made within 30 days of Notice to Proceed. After the 30 day period, no requests for substitutions from the Contractor will be considered.
  - 1. Substitution submitted within the first 30 days will have product data from specified and requested substitute submitted together and demonstrate better quality, cost savings if of equal quality, or show benefit to the County for excepting the substitute.
- F. Once electronic submittals are approved or approved as noted, they will be transmitted to the owner.

1.04 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Critical Path Method (CPM) Schedule: Prepare a fully developed, horizontal bar-chart type Contractor's construction schedule.
  - 1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the work as indicated in the Schedule of Values.
  - 2. Within each time bar, indicate estimated completion percentage in 10 percent increments. As work progresses, place a contrasting mark in each bar to indicate Actual Completion.
  - 3. Prepare the schedule on a sheet, series of sheets, stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
  - 4. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work.
  - 5. Coordinate the Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment request and other schedules.
  - 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Engineer's procedures necessary for certification of Substantial Completion.
- B. Phasing: Provide notations on the schedule to show how the sequence of the work is affected by requirements for phased completion to permit work by separate Contractors and partial occupancy by the Owner prior to Substantial Completion.
- C. Work Stages: Indicate important stages of construction for each major portion of the work, including testing and installation.
- D. Area Separations: Provide a separate time bar to identify each major construction area for each major portion of the work. Indicate where each element in an area must be sequenced or integrated with other activities.
- E. Cost Correlation: At the head of the schedule, provide a two item cost correlation line, indicating precalculated and actual costs. On the line show dollar-volume of work performed as the dates used for preparation of payment requests.
  - 1. Refer to Section Applications for Payment for cost reporting and payment procedures.

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- F. Distribution: Following response to the initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the project meeting room and temporary field office.
  - 1. When revision are made distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
- G. Schedule Updating: Revise the schedule monthly or activity, where revisions have been recognized or made. Issue the updated schedule concurrently monthly pay request.

1.05 SUBMITTAL LOG

- A. After development and acceptance of the Contractor's construction schedule, prepare a complete log of submittals.
  - 1. Coordinate submittals log with the list of subcontracts, schedule of values and the list of products as well as the Contractor's construction schedule.
  - 2. Prepare the log in chronological order; include all submittals required. Provide the following information:
    - a. Scheduled date for the first submittal
    - b. Related Section number
    - c. Submittal category
    - d. Name of subcontractor
    - e. Description of the part of the work covered
    - f. Scheduled date for resubmittal
    - g. Scheduled date for the Engineer's final release or approval.
  - 3. All submittals must be received within the first 25% of contract time.
- B. Distribution: Following response to initial submittal, print and distribute copies to the Project Manager, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the project meeting room and field office.
  - 1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
- C. Log Updating: Revise the log after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

1.06 DAILY CONSTRUCTION REPORTS

- A. Prepare a daily construction report, recording the following information concerning events at the site; and submit duplicate copies to the Project Manager at weekly intervals:
  - 1. List of subcontractors at the site
  - 2. Approximate count of personnel at the site
  - 3. High and low temperatures, general weather conditions
  - 4. Accidents and unusual events
  - 5. Meetings and significant decisions
  - 6. Stoppages, delays, shortages, losses
  - 7. Meter readings and similar recordings



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8. Emergency procedures
9. Orders and requests of governing authorities
10. Change Orders received, implemented
11. Services connected, disconnected
12. Equipment or system tests and start-ups
13. Partial completions, occupancies
14. Substantial Completions authorized

1.07 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered a Shop Drawings and will be rejected.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:
  1. All required dimensions
  2. Identification of products and materials included
  3. Compliance with specified standards
  4. Notation of coordination requirements
  5. Notation of dimensions established by field measurement
  6. Sheet Size: Except for templates, patterns and similar full-size Drawings on sheets at least 8" x 11" but no larger than 24" x 36".
  7. Number of Copies: Submit one (1) electronic copy of each submittal to the County's Representative, unless copies are required for operation and maintenance manuals. Submit one (1) electronic copy where copies are required for operation and maintenance manuals. Engineer will retain 1 electronic copy. Mark up and retain one returned electronic copy as a Project Record Drawing.
  8. Submit one (1) hard copy once approved for legal seal stamping if needed at jobsite. Coordinate with Engineer and County's Representative.
  9. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connections with construction.
- C. Coordination drawings are a special type of Shop Drawing that show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or function as intended.
  1. Preparation of coordination Drawings is specified in section Project Coordination and may include components previously shown in detail on Shop Drawings or Product Data.
  2. Submit coordination Drawings for integration of different construction elements. Show sequence and relationships of separate components to avoid any conflict including conflicts in use of space.
  3. Contractor is not entitled to additional payments due to lack of compliance with this Section.

1.08 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as "Shop Drawing".

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1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
  - a. Manufacturer's printed recommendations
  - b. Compliance with recognized trade association standards
  - c. Compliance with recognized testing agency standards
  - d. Application of testing agency labels and seals
  - e. Notation of dimensions verified by field measurement
  - f. Notation of coordination requirements
  - g. Manufacturers local representative and phone number.
2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
3. Preliminary Submittal: Submit a preliminary single-copy of Product Data where selection of options is required.
4. Submittals: Submit six (6) copies of each required submittal. The Project Manager will return two (2) sets to the Contractor marked with action taken and corrections or modifications required.
  - a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
5. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
  - a. Do not proceed with installation until an applicable copy of Product Data applicable is in the Installer's possession.
  - b. Do not permit use of unmarked copies of Product Data in connection with construction.

1.09 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer/Project Manager will review each submittal, mark to indicate action taken, and return promptly.
  1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Stamp: The Engineer/Project Manager will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, similarly as follows, to indicate the action taken:
  1. Final Unrestricted Release: Where submittals are marked No Exceptions Taken, that part of the work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
  2. Final-But-Restricted Release: When submittals are marked Made Corrections Noted that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
  3. Returned for Resubmittal: When submittal is marked Revise and Resubmit, do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new

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submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

- a. Do not permit submittals marked Revise and Resubmit to be used at the Project site, or elsewhere where work is in progress.
4. Rejected: Submittal does not comply with requirements of the Contract Documents. Submittal must be discarded and entirely new submittal shall be forward to the Project Manager without delay.

PART 2 PRODUCTS (Not Applicable)

PART 3 Execution (Not Applicable)

END OF SECTION 01300

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SECTION 01400  
QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1-16 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF REQUIREMENTS:

- A. Required inspection and testing services are intended to assist in the determination of probable compliance of the work with requirements specified or indicated. These required services do not relieve the Subcontractor of responsibility for compliance with these requirements or for compliance with requirements of the Contract Documents.
- B. Definitions: The requirements of this section relate primarily to customized fabrication and installation procedures, not to the production of standard products. Quality control services include inspections and tests and related actions, including reports, performed by independent agencies and governing authorities as well as directly by the Subcontractor. These services do not include Contract enforcement activities performed directly by the Construction Manager or Architect or Engineer.
  - 1) Specific quality control requirements for individual units of work are specified in the section of these specifications that specify the individual element of the work. These requirements, including inspections and tests, cover both production of standard products and fabrication of customized work. These requirements also cover quality control of the installation procedures.
  - 2) Inspections, tests and related actions specified in this section and elsewhere in the Contract Documents are not intended to limit the Subcontractor's own quality control procedures which facilitate overall compliance with requirements of the Contract Documents.
  - 3) Requirements for the Subcontractor to provide quality control services as required by the Construction Manager, A/E, the Owner, governing authorities or other authorized entities are not limited by the provisions of this section.

1.03 RESPONSIBILITIES:

- A. Construction Manager and Subcontractor Responsibilities: Except where specifically indicated as being provided by another, identified entity, inspections, tests and similar quality control services are the Subcontractor's responsibility; these services also include those specified to be performed by an independent agency and not directly by the Subcontractor. Costs for these services shall be included in the Contract Sum., except quality control services listed as being provided by the Construction Manager. The Construction Manager shall employ and pay an independent agency, testing laboratory or other qualified firm to perform quality control services for the following ; soils compaction, soils moisture, sieve analysis, concrete, structural bolted and welded connections, mortar strength, masonry, and paving.
- B. Retest Responsibility: Where results of required inspections, tests or similar services prove unsatisfactory and do not indicate compliance of related work with the requirements of the Contract Documents, then retests are the responsibility of the Subcontractor, regardless of whether the original test was the Subcontractor's

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responsibility. Retest the work revised or replaced by the Subcontractor is the Subcontractor's responsibility, where required tests were performed on original work.

- C. Responsibility for Associated Services: The Subcontractor is required to cooperate with the independent agencies performing required inspections, tests and similar services. Provide such auxiliary services as are reasonably requested. Notify the testing agency sufficiently in advance of operations to permit assignment of personnel. These auxiliary services include but are not necessarily limited to the following:

Providing access to the work.

Taking samples or assistance with taking samples.

Delivery of samples to test laboratories.

Security and protection of samples and test equipment at the project site.

- D. Coordination: The Subcontractor and each independent agency engaged to perform inspections, tests and similar services for the project shall coordinate the sequence of their activities so as to accommodate required services with a minimum of delay in the progress of the work. In addition, the Subcontractor and each independent testing agency shall coordinate their work so as to avoid the necessity of removing and replacing work to accommodate inspections and tests. The Subcontractor is responsible for advising the Construction Manager at least 48 hours in advance of the required times for inspections, tests, taking of samples and similar activities.

1.04 QUALITY ASSURANCE:

- A. Qualification for Service Agencies: Except as otherwise indicated, the engage inspection and test service agencies, including independent testing laboratories, which are pre qualified as complying with "Recommended Requirements for Independent Laboratory Qualification" by the American Council of Independent Laboratories and which are recognized in the industry as specialized in the types of inspections and tests to be performed.

1.05 SUBMITTALS:

- A. Refer to Division 1 section on "Submittals" for the general requirements on submittals. Submit Four(4) copies of the certified written report of each inspection, test or similar service. Two (2) shall be submitted directly to the Construction Manager and two (2) directly to the A/E. Submit additional copies of each written report directly to the governing authority, when the authority so directs.

- 1) Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to the following:

Name of testing agency or test laboratory.

Dates and locations of samples and tests or inspections.

Names of individuals making the inspection or test.

Designation of the work and test method.

Complete inspection or test data.

Test results.

Interpretations of test results.

Notation of significant ambient conditions at the time of taking sample and testing.

Comments or professional opinion as to whether inspected or tested work complies with requirements of the Contract Documents.

Recommendations on retesting, if applicable.

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PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION:

- A. Upon completion of inspection, testing, sample-taking and similar services performed on the work, repair damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed finishes. Comply with the Contract Document requirements for "Cutting and Patching". Protect work exposed by or for quality control service activities, and protect repaired work. Repair and protection is the Subcontractor's responsibility, regardless of the assignment of responsibility for inspection, testing or similar services.

END OF SECTION 01400

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SECTION 01631  
PRODUCTS SUBSTITUTIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary conditions and other Division-1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling request for substitutions made during bidding and after award of the Contract.
- B. The Contractor's Installation Schedule and the Schedule of Submittals are included under Section "Submittals".
- C. Standards: Refer to Section "Definitions and Standards" for applicability of industry standards to products specified.
- D. Procedural requirements governing the Contractor's selection of products and product options are included under Section "Materials and Equipment".

1.03 DEFINITIONS

- A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: The Contract will be awarded based on the design, methods, materials and/or equipment as addressed in the Contract Drawings and/or described in the Contract Specifications, without any consideration for substitution or "or-equal" replacement. Addressing, describing or naming an item is intended to establish the type, function, characteristics and quality required in order to establish a base for bidding.
  - 1. Within thirty (30) days after Contract award, the Contractor may submit for approval substitutes for any equipment and/or material. In addition to the product documents, a written certification shall accompany the documentation indicating that the proposed substitute will have the same characteristics, will perform in accordance with the design requirements and that complies with all the requirements set for in the Contract. Any additional information required by the Owner or County Representative shall be provided by the Contractor. Rejection of any proposed substitute will be considered final and the Contractor shall not get into any agreement with manufacturers or providers until the submittal has been finally approved.
  - 2. The submission of this documentation shall follow the requirements set quality required in order to establish a base for bidding.

1.04 SUBMITTALS

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- A. Substitution Request Submittal: Request for substitution will be considered if received within thirty (30) days after contract award. As long as this time allowance will not impact the construction schedule.
1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.
  2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitution, and the following information, as appropriate:
    - a. Product Data, including Drawings, and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
    - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
    - e. A statement indicating the substitution's effect on the Contractor's construction schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
    - g. Certification by the Contractor that the Substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
  3. Engineer's Action: Within two weeks of receipt of the request for substitution, the Engineer will request additional information or documentation necessary for evaluation of the request if needed. Within two (2) weeks of receipt of the request, or one week of receipt of the additional information or documentation, whichever is later, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the project specified by name. Decision on the use of a product substitution or its rejection by the Engineer is considered final. Acceptance will be in the form of a Change Order.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

- A. Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise request will be returned without action except to record noncompliance with these requirements.



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1. Extensive revisions to Contract Documents are not required.
  2. Proposed changes are in keeping with the general intent of Contract Documents.
  3. The request is timely, fully documented and properly submitted.
  4. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the work promptly or coordinate activities properly.
  5. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
  6. A substantial advantage is offered to the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar consideration.
  7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
  8. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
  9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provide the required warranty.
- B. The Contractor's submittal and Project Manager's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.
- C. Substitution request constitutes a representation that the Contractor:
1. Has investigated proposed product and determined that it meets or exceeds, in all respects, specified product.
  2. Will provide the same warranty for substitution as for specified product.
  3. Will coordinate installation and make other changes which may be required for work to be complete in all respects.
  4. Waives claims for additional costs which may subsequently become apparent. All costs associated with the substitution will be paid by the Contractor regardless of approvals given, and regardless of subsequent difficulties experienced as a result of substitutions.

END OF SECTION 01631

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SECTION 01700  
PROJECT CLOSE-OUT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies administrative and procedural requirements for project close-out, including but not limited to:
  - 1. Inspection procedures
  - 2. Project record document submittal. (substantial completion requirements)
  - 3. Operating and Maintenance Manual Submittal (substantial completion requirements).
  - 4. Submittal of warranties (substantial completion requirement).
  - 5. Final cleaning
- B. Close-out requirements for specific construction activities are included in the appropriate Sections in Divisions 15 through 16.
- C. Final Payment to be made when the County has reviewed and accepted all required close-out documents.

1.03 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for Certification of Substantial Completion, complete the following: List exceptions in the request.
  - 1. In the Application for Payment that coincided with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
    - a. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.
  - 2. Advise Owner of pending insurance change-over requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
  - 4. Obtain and submit releases enabling the Owner unrestricted use of the work and access to services and utilities; include occupancy permits, operating certificates and similar releases.
  - 5. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- B. Inspection Procedures: On receipt of a request for inspection, the Project Manager will either proceed with inspection or advise the Contractor of unfilled requirements. The Project Manager will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

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1. Results of the completed inspection will form the basis of requirements for final acceptance.
2. Should the project fail to meet the standards required for Substantial Completion as defined in the documents, the Contractor will pay the expense of a second inspection by the Engineer and the Owner. Cost will be deducted from the Contractor's retainage.

1.04 FINAL ACCEPTANCE

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following list exceptions in the request:
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and complete operations where required.
  2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
  3. Submit a certified copy of the Engineer or Owner's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by the Project Manager.
  4. Submit final meter readings for utilities, a measured record of stored fuel and similar data as of the date of Substantial Completion, or when the Owner took possession of the responsibility for corresponding elements of the Work.
  5. Submit consent of surety to final payment.
  6. Submit a final liquidated damages settlement statement
  7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Reinspection Procedure: The Engineer will reinspect the work upon receipt of notice that the work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Engineer.
1. Upon completion of reinspection, the Engineer will prepare a certification of final acceptance, or advise the contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

1.05 RECORD DOCUMENT SUBMITTALS

- A. General: Do not use record documents for construction purposed; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation; where the installation varies substantially from the work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the
- C. Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Provide for project photographs if deemed necessary by Owner's representative.
1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the work.

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2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
  3. Note related Change Order numbers where applicable.
  4. **Submit one (1) hardcopy of the most current record set of drawings when the project is considered 50% substantially complete for review and comment by Owner.**
  5. Organize record drawing sheets, and print suitable titles, dates and other identification on the cover of each set.
  6. Provide three (3) additional sets of black line drawing sets of As-Built Drawings.
  7. Provide one (1) CD-ROM with all As-Built Drawings in AutoCAD and PDF format.
- D. Record Specifications: Maintain one complete copy of the Project Manual, including addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction. Mark these documents to show substantial variations in actual work performed in comparison with the text of the specifications and modifications. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related record drawing information and Project Data.
1. Upon completion of the Work, submit record Specifications to the Engineer for the Owner's records.
- E. Record Project Data: Maintain one copy of each Product Data submittal. Mark these documents to show significant variation in actual work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily discerned later by direct observation. Note related Change Orders and mark-up of record drawings and Specifications.
1. Upon completion of mark-up, submit complete set of record Product Data in the three ring binder (indexed) to the Engineer for the Owner's records.
- F. Record Sample Submitted: Immediately prior to the date or dates of substantial completion, the Contractor will meet at the site with the Engineer and the Owner's personnel to determine which of the submitted Samples that have been maintained during progress of the work are to be transmitted to the Owner for record purposes. Comply with delivery to the Owner's Sample storage area.
- G. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the work. Immediately prior to the date or dates of substantial completion, complete miscellaneous record and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Project Manager for the Owner's records.
- H. Maintenance Manuals: Organize operating and maintenance data into four (4) suitable sets of manageable size and electronically as PDFs on one (1) CD-ROM compact disc. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:
1. Emergency instructions
  2. Spare parts list
  3. Copies of warranties

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4. Wiring diagrams
5. Recommended turn-around cycles
6. Inspection procedures
7. Shop Drawings and Product Data
8. Fixture lamping schedule

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 CLOSE-OUT PROCEDURES

- A. Operating and Maintenance Instructions: Arrange for each installer of equipment that required regular maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. All items to be provided or completed prior to Certificate of Substantial Completion being issued by the Owner. Include a detailed review of the following items:

1. Maintenance manuals
2. Record documents
3. Spare parts and materials
4. Tools
5. Lubricants
6. Fuels
7. Identification systems
8. Control sequences
9. Hazards
10. Cleaning
11. Warranties and bonds
12. Maintenance agreements and similar continuing commitments
13. On site instructions to County maintenance personnel on major systems operations such as HVAC as per technical specifications.

- B. As part of instruction for operating equipment, demonstrate the following procedures, prior to the Owner issuing Certificate of Substantial Completion:

1. Start-up
2. Shutdown
3. Emergency operations
4. Noise and vibration adjustments
5. Safety procedures
6. Economy and efficiency adjustments

3.02 PROJECT CLOSE-OUT MANUALS AT SUBSTANTIAL COMPLETION

- A. Submit Project Close-out Manuals prior to issuance of final application for payment. Provide one (1) hardcopy.
- B. Bind in commercial quality 8 ½" x 11" three ring binder, indexed with hardback, cleanable, plastic covers.
- C. Label cover of each binder with typed title PROJECT CLOSE-OUT MANUAL, with title of project; name, address, and telephone number of Contractor and name of responsible Principal.
- D. Provide table of contents: Neatly typed, in the following sequence:
1. Final Certificate of Occupancy
  2. Warranty Service Subcontractors Identification List

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3. Final Lien Waivers and Releases
  4. Warranties and Guarantees
  5. Systems Operations and Maintenance Instruction
  6. Manufacturer's Certificates and Certifications
  7. Maintenance Service Contracts
  8. Spare Parts Inventory List
  9. Special Systems Operating Permits or Approvals
  10. Asbestos free materials notarized statement
- E. Provide all documents for each section listed. List individual documents in each section in the Table of Contents, in the sequence of the Table of Contents of the Project Manual.
- F. Identify each document listed in the Table of Contents with the number and title of the specification section in which specified, and the name of the product or work item.
- G. Separate each section with index to sheets that are keyed to the Table of Contents listing.
- H. Warranty Service Subcontractors List shall identify subcontractor supplier, and manufacturer for each warranty with name, address and emergency telephone number.
- I. Electronic Close-out DVD: At the completion of the project, submit one copy of a DVD with entire project close out information below in PDF format. All letter, legal and brochure size sheets shall be portrait and the As-build drawings will be landscape. All fonts will be Arial. All items will be in PDF with OCR (Optical Character Recognition). This will enable a search engine to identify words on the scanned documents.
1. Contacts: Set up a separate PDF for the contacts. No bookmarks are needed for this section.
  2. As-Built: All as-built drawings will be landscape.
  3. Submittals: All technical submittal items (approved and approved as noted) will be provided and sorted by the 16 standard divisions. Bookmarks will be needed for the appropriate divisions.
  4. Operations and Maintenance Manual: Specify the division name only in the bookmarks (1-16). Please note that all items will be in PDF with OCR (Optical Character Recognition). This will enable a search engine to identify works on the scanned documents.
  5. Permitting: This should include the Certificate of Occupancy and any other document that the Project Manager may include pertaining to the permitting for the project.

3.03 FINAL CLEANING

- A. General: General cleaning during construction is required by the General Conditions and included in Section - Temporary Facilities.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
    - a. Remove labels that are not permanent labels.
    - b. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are

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- noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
  - c. Clean exposed exterior and interior hard-surfaced finished to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
  - d. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
  - e. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas broom clean; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even-textured surface. Remove waste and surplus materials from the site in an appropriate manner.
- C. Removal of Protection: Remove temporary protection and facilities installed for protection of the work during construction.
- D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove waste materials from the site and dispose of in a lawful manner.
  - 1. Where extra materials of value remaining after completion of associated work have become the Owner's property, arrange for disposition of these materials as directed.

END OF SECTION 01700

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SECTION 01740  
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contractor Documents, including manufacturers standard warranties on products and special warranties.
  - 1. Refer to the General Conditions for terms of the Contractor's special warranty of workmanship and materials.
  - 2. General close-out requirements are included in Section "Project Close-Out".
  - 3. Specific requirements for warranties for the work and products and installations that are specified to be warranted, are included in this document.
  - 4. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties to not relieve the Contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.03 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- B. Reinstatement of Warranty. When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
  - . Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligation, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligation, rights, or remedies.
  - 1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- E. The Owner reserves the right to refuse to accept work for the Project where a special warranty, certification, or similar commitment is required on such work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.



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1.04 WARRANTY PERIOD

- A. The Contractor shall participate with the County and the Engineer's representative, at the beginning of the tenth month of the warranty period, in conducting an on site review and evaluation of all items of equipment, materials and workmanship covered by the warranties and guarantees. Contractor shall act promptly and without cost to the County to correct all defects, problems, or deficiencies determined as such by the Engineer/Owner during on the site review.
- B. All warranties and guarantees shall commence on the date of Substantial Completion except for items which are determined by the County to be incomplete or a non-comply status at the time of Substantial Completion. The coverage commencement date for warranties and guarantees of such work shall be the date of the County's acceptance of that work.
- C. Warranty period shall be manufacturer's standard for product specified except where specific warranty periods are specified in individual sections. But in no case less than one year.

1.05 SUBMITTALS

- A. Submit written warranties to the Owner prior to the date certified for Substantial Completion. If the Engineer's Certificate of substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the work, submit written warranties upon request of the Project Manager.
  - 1. When a designated portion of the work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Project Manager within fifteen days of completion of that designated portion of the work.
- B. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepared a written document that contains appropriate terms and identification, ready for executing by the required parties. Submit a draft to the Engineer for approval prior to final execution.
  - 1. Refer to individual Sections of Division 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.
- C. Form of Submittal: At Final Completion compile two (2) copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- D. Bind (3) three sets of warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8 1/2" by 11" paper.
  - 1. Provide heavy paper dividers with Celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor.

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3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION 01740

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SECTION 02070  
DEMOLITION AND ALTERATIONS

PART 1 - GENERAL

1.1 SCOPE OF SECTION

- A. Cut, demolish and remove existing work associated with the renovation. Cut and remove existing work as indicated or necessary to fit new work to existing that is to remain. Where practical, salvage existing items that may be reused or are indicated for reuse or to be turned over to Owner.

1.2 REFERENCE STANDARDS

- A. The latest edition of publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- 1. ASTM E 84 Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- 2. NFPA 241 Safeguarding Construction, Alteration and Demolition Operations

- B. Unknown Conditions: Work shall not include Contractor's identification, detection, abatement, encapsulation or removal of asbestos or similar hazardous substance(s). In the course of performing this work, if such material/product is encountered, discontinue work and remove workers from the project until such material/product and hazards connected therewith are abated, encapsulated or removed, or it is determined that no hazard exists. An extension of time will be granted for delay resulting from such condition and correction.

- C. Structural Members: Do not cut any building structure without written authorization of the Engineer. Any structural members intentionally cut without proper authorization or accidentally cut shall be restored to their original integrity and condition.

- 1. Do not cut or drill existing concrete pre cast slabs. Use existing chases and openings at floor slabs.

1.3 PROTECTION

- A. Safety: Before commencing any work, provide warning signs, lights, barricades, fences, rails and other safety devices. Exercise caution when working adjacent to spaces occupied by Owner's personnel.

- B. Temporary Work: Do not commence demolition until temporary shoring, bracing, partitions, exits and other support and protective measures have been properly installed.

- C. Temporary Partitions and Closures: Where new existing openings are created and where work is in occupied spaces or existing equipment, provide physical separation and protect from dust and moisture with partitions and closures. Maintain partitions in place until new work has been completed and provide protection from the weather and dust. Before and during removal, clean all surfaces with a vacuum cleaner (to avoid dispersion of dust).

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- D. Portable Coverings: For minor interior alterations, where acceptable to Engineer, flame-proofed drop cloths may be used. Plastic sheet or film shall not be used for any purpose for interior work.
- E. Air filters: During Demolition provide portable air filters as part of dust control.
- F. Wet mop concrete floors slab to control dust.
- G. Vacuum space every day at the completion of the work.

1.4 SECURITY

- A. Establish procedures and execute operations to provide continuous security. Provide temporary protection for openings and at other locations as may be appropriate during construction. Deny entrance of unauthorized persons into work area.

1.5 HOUSEKEEPING

- A. Collect debris, rubbish and trash resulting from operations at designated places. Sprinkle dusty debris with water. Handle in a controlled manner. Do not accumulate waste unnecessarily; remove promptly from premises; generally daily. Sweep and vacuum floors in work areas as frequently as necessary to maintain premises in acceptable condition for continuous, uninterrupted operation by Owner.

1.6 OCCUPIED SPACES

- A. Since the building will maintain operations, coordination will be required with building staff and owners representative to coordinate time of demolition to minimize disturbance occupants.

PART 2 - MATERIALS

2.1 LUMBER

- A. Wood and plywood used in building temporary partitions shall be fire-retardant treated to provide flame spread rating, per ASTM E 84, or maximum of twenty-five (25).

2.2 TAPE

- A. Kraft paper two (2) inches wide with pressure sensitive adhesive one side. Shear strength (peel adhesion); 60-oz. per inch width. Acceptable: FasTape.

2.3 TEMPORARY CLOSURES

- A. In addition to the requirements of Division 0, flame-proofed drop cloths (not flammable plastic), UL labeled, flame spread maximum fifteen (15). Where daylight would be beneficial for workmanship and reduce need of artificial illumination, translucent polyvinyl chloride film reinforced in diamond pattern with 33 nylon threads per foot. Acceptable: "Griffolyn" T-55-FR, Reed Industries, Box 248, Houston, Texas 77233, phone 800/231-6074.

PART 3 - EXECUTION

3.1 RELOCATION AND REMOVAL

- A. Temporarily remove or suitably relocate designated equipment, utilities or services to

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clear the work, or to properly function in the complete installation. Where services or utilities are removed, suitable cap or terminate according to applicable ordinances and requirements of governing authorities and/or per other sections of specifications and drawings. Where such items interfere with the work and specific instructions are not included on the drawings, they shall be adequately protected and further instructions requested from the Engineer. Existing construction that does not interfere with new work and will be concealed may remain in place unless indicated to be removed.

3.2 PORTABLE COVERINGS

- A. For interior alterations, where acceptable to Engineer, flame-proofed drop cloths may be used. Flammable plastic sheet or film shall not be used within the building.

3.3 DEMOLITION

- A. Plan of Operations: Establish procedures for safe removal of parts by methods that will not transmit excessive vibrations to or eccentric loads on building structure, create a nuisance, damage existing work that will remain, nor endanger either workmen, public, occupants nor adjacent work.
- B. Supervision: Cut and demolish under supervision of a competent foreman, capable of identifying hazardous conditions and authorized to promptly take corrective action to eliminate them.
- C. Precaution: Exercise care to avoid unnecessary damage to work that shall remain or stored for reinstallation.
- D. Hole Cutting: Neatly cut holes where necessary. Keep area and debris covered to minimize creation of dust. Use care and adjust hole locations as required to minimize necessary cutting.
- E. Finishes and Exposed Work: Cut to true and straight lines to permit satisfactory refinishing or connection to new work. Remove items to nearest full piece that is to remain.

3.4 OWNERSHIP OF MATERIALS

- A. Salvaged materials that are to be relocated or remain the property of the Owner shall be carefully removed and stored on the site for reuse or disposition specified. Other materials become the property of Contractor and shall be removed and disposed of off the site.

3.5 SALVAGE OPERATIONS

- A. Salvage existing materials/products identified to be reused or turned over to Owner. Carefully remove, collect, protect, repair, clean or restore to first class condition, relocate and reinstall where and as indicated. After cleaning and repairing salvaged items to be furnished to Owner, place in location on premises designated by Owner's representative.

3.6 REMOVAL

- A. Remove materials/products/equipment which are not to be reused in the work in an orderly and careful manner so as not to endanger or damage adjacent work which is to remain. When removing nails by claw hammer, place a small piece of wood under the hammer head to keep claws at right angle to the nail and prevent damage to the surface.

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3.7 DISPOSAL

- A. Haul rubbish, debris and unusable material away from the site promptly and dispose of legally. Burning on site is prohibited.

3.8 CLEANING

- A. Clean surfaces as described in specifications.

3.9 CONCRETE

- A. Exercise due caution in cutting and patching, chipping or general concreting so as not to deface that portion of the existing structure which is to remain. Should any such impairment occur, immediately clean or restore to original condition at no cost to Owner.
- B. Do not cut or core existing, concrete slabs, columns, joist and beams.
- C. Patch all existing slab penetrations caused by demolition of mechanical and plumbing with rated and UL listed seal assembly.

3.10 UTILITIES AND RELATED EQUIPMENT, PLUMBING, AND ELECTRICAL WORK

- A. Protect existing utilities, storm, waste, water, fire protection, conduit racks, refrigerant pipes and raceways as indicated and as uncovered by the work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Engineer. If electrical, communications, fire protection and systems lines are encountered and not shown on drawings, contact the Engineer prior to the start of the work.

3.11 DRYWALL

- A. Within the limits of the work, should any portion of existing drywall surfaces be deemed broken, scratched or unfastened, spackle with drywall compound, refasten or other wise repairs. Where indicated on the drawings for drywall to be removed remove the covering, base, drywall board, vapor barrier, insulation, metal furring and all fasteners.
- B. Within the limits of the work make repairs to drywall partitions. Match adjacent surfaces or as indicated on the drawing.
- C. Within the limits of tile work remove drywall ceiling and ceiling suspension system and supports, fasteners complete.

3.12 PATCHING

- A. Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Finished surfaces of patched area shall flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish.
- B. Where patching occurs on rated partition or fireproofed structure repair to match existing UL rated system to match code required hourly rating for assembly.

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3.13 FIRESTOPPING AND DRAFT STOPPING

- A. Fire stop existing holes at all masonry walls, floor slab & GWB Partitions.
- B. Fire stop existing open ends of conduits:
- C. Fire stop all existing plumbing penetrations at existing rated walls and floors.
- D. Draft stop all penetrations into cavity of walls, ceilings, and attics. They include all penetrations created by new work or penetrations left by removal of existing proposed for replacement.

3.14. ACOUSTICAL LAY-IN CEILING

- A. Remove and re-install existing acoustical ceiling and suspension system as required by the work U.O.N. on the drawings. If any portion of the existing ceiling is damaged by the G.C. it shall be replaced to match existing.

END OF SECTION 02070

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SECTION 07841  
THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through the fire-resistance-rated assemblies, including both new and existing empty openings and new and existing openings containing penetrating items.
- B. Firestopping shall be designed and constructed in accordance with the Florida Building Code, Florida Fire Code and Uniform Fire Safety Standards as adopted by the State Fire Marshall and latest addendums

1.3 PERFORMANCE REQUIREMENTS

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
  - 1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
  - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
  - 3. Fire-resistance-rated roof assemblies.
  - 4. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  - 5. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
    - Penetrations located outside wall cavities.
    - Penetrations located outside fire-resistive shaft enclosures.
    - Penetrations located in construction containing fire-protection-rated openings.
    - Penetrating items larger than 4-inch (100-mm-) diameter nominal pipe or 16 sq. in. (100 sq. cm) in overall cross-sectional area.
  - 6. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
  - 7. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
  - 8. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.



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9. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
10. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.4 SUBMITTALS

- A. Product Data: For each type of through-penetration firestop system product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
  1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
  2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.
- E. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Installer Qualifications: An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to an installer engaged by Contractor does not in itself confer qualification on buyer.
- C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

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- D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
  2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
    - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

UL in "Fire Resistance Directory."
- E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

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- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

Hilti Construction Chemicals, Inc.  
Nelson Firestop Products.  
3M Fire Protection Products.

2.2 FIRESTOPPING

- A. General: Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- C. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
  - 1. Permanent forming/damming/backing materials, including the following:

Slag-/rock-wool-fiber insulation.  
Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.  
Fire-rated form board.  
Fillers for sealants.
  - 2. Temporary forming materials.
  - 3. Substrate primers.
  - 4. Collars.
  - 5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip,

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a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
  - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
  - 3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
  - 2. Install fill materials for firestop systems by proven techniques to produce the following results:
  - 3. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 4. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 5. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

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3.4 FIELD QUALITY CONTROL

- A. Inspecting Agency: The Contractor shall engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
- B. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.
- D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.5 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Labels shall be installed above ceilings and in concealed spaces. Include the following information on labels:
  - 1. The words: "FIRE AND SMOKE BARRIER PROTECT ALL OPENINGS".  
Contractor's name, address, and phone number.  
Through-penetration firestop system designation of applicable testing and inspecting agency.  
Date of installation.  
Through-penetration firestop system manufacturer's name.  
Installer's name.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 07841

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SECTION 15010  
MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Each Section within Division 15, Mechanical, shall conform to the requirements of the General Conditions of the Contract, including Supplementary General Conditions, Special Conditions, and all requirements of Division 1.
- C. Each Section within Division 15, Mechanical, shall conform to the additional requirements of this Section, Mechanical General Provisions.

1.2 ARTICLES INCLUDED

- A. Definitions.
- B. Permits, Fees and Notices.
- C. Applicable Publications.
- D. Code Compliance.
- E. Scope of Work.
- F. Record Drawings.
- G. Intent of Drawings and Specifications.
- H. Quality Assurance
- I. Submittals.
- J. Product Requirements, Equals and Substitutions.
- K. Manufacturers Instructions.
- L. Transportation and Handling.
- M. Storage and Protection.
- N. Cutting, Patching and Demolition.
- O. Cleaning Up/Removal of Debris.
- P. Starting of Mechanical Systems.
- Q. Operating and Maintenance Manuals.
- R. Training of Owners Operators.

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S. Guarantee of Work.

T. System Testing.

1.3 ARTICLES

A. Definitions:

1. The term "As indicated" means as shown on drawings by notes, graphics or schedules, or written into other portions of contract documents. Terms such as "shown", "noted", "scheduled" and "specified" have same meaning as "indicated", and are used to assist the reader in locating particular information.
2. The term "Provide", means furnish and install as part of the work covered in Division 15.
3. The term "Furnish" means furnish only, for installation, as part of this contract, by other Divisions.
4. The term "Install only" means to install under the work of Division 15 equipment furnished by other Divisions, or by the Owner.
5. The term "Owner's Representative" when referenced herein shall be the Architect or the Engineer acting as his designated representative unless otherwise noted.
6. The term "design" as it pertains to the work of this division shall describe the basic intent, component sizing, component relationships and overall architecture of the HVAC, plumbing and fire protection system. The design is generally schematic in nature and will require specific detailing after the accepted products are determined.
7. The term "detail" as it pertains to the work of this division shall describe the work required by the contractor to assure a fully coordinated installation of the material and equipment supplied. When requested, the contractor shall produce detailed shop drawings or sketches indicating the actual placement of the equipment or material supplied; also including how the equipment or material interfaces with work of other sections or divisions within the contract documents.
8. The term "workman-like manner" as it pertains to the work of this division shall describe a neat well organized high quality installation system (duct, pipe, control wire or tube, conduit, etc.). Routing shall be well thought out providing adequate service clearance and maximum use of space. Equipment placement shall exhibit proper clearances for service. All lines (duct, pipe, control wire or tube, conduit, etc.) shall be run straight and true, parallel or perpendicular to building structure neatly supported.
9. For additional definitions refer to the Division 1 requirements.

B. Permits, Fees and Notices: Comply with the Division 1 requirements.

C. Applicable Publications:

1. Publications listed in each Section form a part of that Section to the extent referenced.
2. When a standard is specified by reference, comply with requirements of that standard, except when requirements are modified by the Contract Documents, or applicable codes establish stricter standards.
3. The Publication or Standard is the publication in effect as of the bid date, except when a specific date is listed.

D. Code Compliance:

1. 2006 Life Safety Code - NFPA 101
2. 2010 The Florida Building Code



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3. 2010 The Florida Accessibility Code for Building Construction
  4. 2008 National Electric Code (NEC)
  5. 2010 The Florida Building Code – Mechanical
  6. 2009 NFPA Standards
- E. Scope of Work: The work to be performed under this Division consists of the satisfactory completion of all HEATING, VENTILATING, AIR CONDITIONING, as indicated in the Contract Documents.
- F. Record Drawings: Comply with the Division 1 requirements.
- G. Intent of Drawings and Specifications:
1. The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
  2. Existing conditions, dimensions, etcetera, depicted on the drawings are taken from the "as-built" drawings of the original construction supplemented by field observation. The contractor is cautioned to field verify all existing conditions, dimensions, etcetera, notifying the Owner's Representative of any discrepancies other than those minor in nature, for direction, prior to ordering or fabricating equipment or materials. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawing and specifications, the more stringent shall govern, unless the discrepancy conflicts with applicable codes, wherein the code shall govern.
  3. The drawings are diagrammatic, intending to show general arrangement, capacity and location of system components, and are not intended to be rigid in detail. Final placement of equipment, other system components, and coordination of all related trades shall be the contractor's responsibility.
  4. Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets and fittings may not be shown but shall be provided at no additional change in contract cost.
  5. In the event of a conflict, the Owner's Representative will render an interpretation in accordance with the General Conditions.
- H. Quality Assurance:
1. All equipment furnished under this Division shall be listed and labeled by U.L., ETL or a nationally recognized testing laboratory (NRTL).
  2. Material furnished under this Division shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such material and shall be the latest design.
  3. Materials shall be the best of their respective kinds. Materials shall be new except where the specifications permit reuse of certain existing materials.
  4. Work provided for in these specifications shall be constructed and finished in every part in a workmanlike manner.
  5. All items necessary for the completion of the work and the successful operation of a product shall be provided even though not fully specified or indicated on the drawings.
  6. All work to be performed by qualified and experienced personnel specifically trained in their respective field.
  7. All work of this division shall be carefully interfaced with the work of other divisions to assure a complete, functioning system or systems.

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- I. Submittals: Comply with the Division 1 requirements.
- J. Product Requirements, Equals and Substitutions: Comply with the Division 1 requirements.
- K. Manufacturer's Instructions:
  - 1. Installation of work shall comply with manufacturer's printed instructions.
  - 2. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Owner's Representative for clarification. Do not proceed with work without clear instructions.
- L. Transportation and Handling: Comply with the Division 1 requirements.
- M. Storage and Protection:
  - 1. Store products in accord with manufacturer's instructions, with seals and labels intact and legible.
  - 2. Store products to prevent damage by the elements. Space temperature shall be controlled as required to prevent condensation and metal corrosion or damage to electrical or electronic parts are the result of condensation.
  - 3. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.
  - 4. Provide protection as necessary to prevent damage after installation.
  - 5. Products which suffer damage due to improper storage shall not be installed and if found in place, shall be removed and replaced at the contractors expense.
- N. Cutting and Patching: Comply with the Division 1 requirements.
- O. Cleaning Up/Removal of Debris:
  - 1. Comply with the Division 1 requirements.
  - 2. Maintain a clean work area. Construction debris shall be immediately removed from all newly erected work.
- P. Starting of Mechanical Systems:
  - 1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
  - 2. Provide labor to assist the Owner's Representative in acceptance review.
  - 3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
  - 4. Provide information and assistance and cooperate with test, adjust and balance services.
  - 5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
  - 6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.
- Q. Operating and Maintenance Manuals: Comply with the Division 1 requirements.
- R. Training of Owners Operators:
  - 1. The owners shall be given comprehensive training in the understanding of the

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- systems and the operation and maintenance of each major piece of equipment.
2. The contractor shall be responsible for scheduling the training which shall start with classroom sessions followed by hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.
  3. Training shall be conducted in a minimum of three sectors. The first, or orientation portion, shall be scheduled prior to system start-up. The second, or equipment portion, shall be scheduled as soon as possible after start-up of the equipment and the third portion, or the TAB and commissioning portion, shall be conducted after completion of this work.
  4. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
  5. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual.
  6. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the O&M manuals and shall emphasize safe and proper operating requirements and preventative maintenance.
  7. The contractor shall attend all sessions and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
  8. The building controls system contractor shall attend all sessions and be prepared to conduct the controls portion of the training as it relates to each equipment section.
  9. The building controls system contractor shall conduct the training session on the controls system hardware and software.
  10. The piping, insulation and sheet metal sub-contractors shall conduct sessions on their respective trades with emphasis on any peculiarities of the systems, pressure limitations and maintenance requirements.
  11. The TAB sub-contractor shall conduct a training session reviewing the procedures and methods used in the TAB process, shall review the TAB data and shall demonstrate use of test equipment which may have been turned over to the owner and shall point out the locations of all pitot traverse locations for the owner's future use.

S. Guarantee of Work:

1. Comply with the Division 1 requirements.
2. Where applicable, furnish manufacturer's written warranty for materials and equipment.
3. Insert warranties in appropriate locations in operating and maintenance manuals.
4. Materials and equipment having seasonal operation limitations, shall be guaranteed for a minimum of one year from date of seasonally appropriate test, and acceptance in writing by the Owner, unless specific Division 15 specifications specify a longer period.

T. System Testing:

1. Provide all necessary labor, materials and equipment to successfully complete all system testing necessary for building occupancy and owner acceptance.
2. Provide all necessary labor, materials and equipment to assist contractors of other division to complete system testing necessary for building occupancy and owner acceptance, wherever an inter-relationship between Division 15 and the work of other divisions exists.
3. Tests shall be repeated as necessary until all occupancy and operation permits

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are granted and the owner accepts the project.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 15010

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SECTION 15020  
HVAC DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Heating, Ventilation and Air Conditioning: Remove all existing heating, ventilating and air conditioning equipment as shown on the Contract Documents.

PART 2 – PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall obtain the permission of the Owners Representative and coordinate with other trades prior to commencement of demolition of the existing installations.
- B. The Contractor shall provide for safe conduct of the work, protection of property, and coordination with other work in progress. The spread of dust and flying particles shall be minimized.
- C. Existing construction to remain shall be protected from damage. Work damaged by the Contractor shall be repaired to match existing work.
- D. When indicated, the contractor shall remove specific equipment in a careful manner so as to maintain the equipment in proper operating order. This equipment will be turned over to the owner and transported to a storage area as directed by the owner and further described herein.
- E. Material demolished under this section shall become the property of the Contractor and shall be promptly removed and disposed of off the site.
- F. Debris and rubbish shall not accumulate on the site, and shall be disposed of periodically by the Contractor.
- G. All necessary precautions shall be taken by the Contractor to prevent spillage during removal activities. Pavement and areas adjacent to the demolition areas shall be kept clean and free from mud, dirt and debris at all times.
- H. Existing utilities and mechanical systems including related equipment shall be disconnected by the Contractor to the extent shown on the contract drawings or specified and as required to perform the work in accordance with Division 15 of the specifications.
- I. The Contractor shall exercise care during the progress of the work under this section so as not to damage or displace the work of the other trades performed under other sections. He shall coordinate work under this section with work under other sections, as necessary for the proper execution of the entire work.
- J. When the contract documents indicate the removal of existing equipment to be

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temporarily stored and to be re-used, the contractor shall provide adequate protection for the stored equipment including the proper capping of several pipe connections, protection of power and control wiring and devices, and draining of coils to prevent freezing damage.

- K. Equipment which contains refrigerants shall be pumped down prior to demolition. The refrigerant shall be properly contained and disposed of in accordance with the accepted local procedures.

END OF SECTION 15020

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SECTION 15050  
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Provisions of Division 7 for Fire and Smoke Stopping requirements.

1.2 WORK INCLUDED

- A. Piping and equipment identification.
- B. Fire and smoke stopping.
- C. Electrical requirements.
- D. Concrete work
- E. Excavation, trenching and backfilling.
- F. Placing of equipment.

1.3 RELATED WORK

- A. DIVISION 7 - Fire and Smoke Stopping.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this Section to the extent referenced.
  - 1. American Institute of Steel Construction (AISC) Publications
  - 2. American National Standards Institute (ANSI) Standards
  - 3. American Society for Testing and Materials (ASTM) Publications
  - 4. American Welding Society (AWS) Publications
  - 5. Underwriters Laboratories, Inc. (UL) Standards

1.5 SUBMITTALS

- A. Where submittals are required, comply with Division 1 requirements.
- B. Submit drawings of fabricated steel supports where proposed supports are not in accordance with details on drawings, or where drawings do not detail supports. Submittal for acceptance is required.
- C. Submittal for other than fabricated steel supports is not required. Product data for the following shall be included in the operation and maintenance manuals. Submittal for acceptance is not required.
  - 1. Piping and equipment identification.
  - 2. Fire and smoke stopping material.

PART 2 - PRODUCTS

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2.1 ACCEPTABLE MANUFACTURERS

A. Piping and Equipment Identification:

1. Communications Technology Corp.
2. Craftmark Identification Systems, Inc.
3. EMED Co., Inc.
4. Florida Marking Products, Inc.
5. Marking Services, Inc.
6. Seton Name Plate Corp.
7. W.H. Brady Co., Signmark Division

B. Fire and Smoke Stopping Material:

1. General Electric Company.
2. Hilti, Inc.
3. International Protective Coatings Corp. (IPC) Division of Grace Construction Prod.
4. Johns Manville
5. Rectorseal
6. Tremco, Inc. Sealant/Weatherproofing Division
7. 3M Fire Protection Products.

2.2 FABRICATION

A. Piping and Equipment Identification:

1. Pipe markers: Sub-surface printed plastic, with protective undercoating. Markers shall be permanently curled for snap-on installation for pipe sizes (including insulation) up to 6" diameter. For external diameters above 8". Marker shall be secured using cable ties for indoor use and stainless steel banding or ultraviolet resistant plastic for exterior use. Markers for outdoor installation shall be overlaminated with Tedlar™ on polyester ultraviolet to avoid damage and fading. Markers shall identify the pipe contents and direction of flow through 360 degree visibility range. Marker size, letter size, letter color, wording and background color shall be in accord with ANSI A13.1 – Scheme for the Identification of Piping Systems. Based on Marking Services Inc. Model MS-970 Coiled Plastic Markers for indoor use and Model MS-995 Maxilar Marker for exterior use or approved equal.
2. Equipment nameplates:
  - a. Indoor: Shall be 1/16 inch thick plastic with black satin surface and white core. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment and 3/4 inch by 2-1/2 inch, with 3/16 inch high lettering for ceiling grid labeling. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to equipment shall be provided.
  - b. Outdoor: Shall be 125 Mil rigid plastic constructed of printed legend sealed between two layers of chemically-resistant plastic to resist ultraviolet damage. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to



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- equipment shall be provided.
- c. Based on Marking Services Inc. Model MS-215 Max-Tex or approved equal.
- B. Fire and Smoke Stopping: Refer to Division 7 for extensive requirements. Fire and smoke stopping material: A one-part silicone elastomer, or a one-part intumescent elastomer caulk or putty, UL classified and FM approved with flame spread of 0 and smoke development not to exceed 50 in accord with ASTM E84. Material shall be suitable for penetration seals through fire-rated floors and walls when tested in accord with ASTM E814 under positive pressure. Material shall not melt or soften at high temperatures, shall be suitable for direct outdoor and ultraviolet exposures, shall cure to give a tight compression fit, and shall not produce toxic fumes. Material, when heated, shall expand to fill and hold penetration closed where burn out of cable insulation or ATC tubing occurs.
- C. Electrical Requirements: Product description not applicable to this Section.
- D. Excavation, Trenching, and Backfilling: Product description not applicable.
- E. Concrete Work:
- 1. Concrete is provided under DIVISION 3 - CONCRETE.
  - 2. This contractor to provide detailed dimension drawings, including anchor bolt locations where required for all bases and pads required for equipment furnished under this Division.
  - 3. Concrete for equipment bases and pads shall be 3000 p.s.i. design mix prepared in accord with ASTM C94. Cement shall be in accord with ASTM C150. Aggregate shall be fine sand in accord with ASTM C33. Water shall be clean, fresh, drinkable.
- F. Placing of Equipment: Product description not applicable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of materials and equipment shall be in accord with the manufacturer's written instructions, except as specified.

3.2 INSTALLATION

- A. Piping and Equipment Identification:
- 1. Install pipe markers adjacent to each valve and fitting, at each branch connection, on each side of wall, floor, and ceiling penetrations, where entering and leaving underground areas, and at minimum 40 foot spacing on horizontal and vertical pipe runs. Markers shall be arranged for easy reading at eye level.
  - 2. Provide air flow diagrams installed in waterproof, laminated frames on the wall in each Mechanical Room. Air flow diagrams shall show locations of dampers, sensors, and exhaust fans associated with the air handling unit.
  - 3. Permanently affix nameplate to each item of equipment using stainless steel pop rivets. Where irregular surface impede direct attachment of plates, affix plate to sheet metal bracket and attach bracket to equipment with screws, bolts or suitable adhesive from nameplate manufacturer.
- B. Fire and Smoke Stopping:
- 1. Refer to Division 7 for further requirements.
  - 2. Fire and smoke stopping shall be provided as required to meet all code requirements

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and at a minimum is required in the following locations:

- a. Where exposed and concealed horizontal pipes, tubes, wires and ducts which are part of an active smoke control system that are not provided with fire dampers penetrate fire rated walls, shaft walls, and smoke barriers.
  - b. Where exposed and concealed vertical pipes, tubes, and wires ducts which are part of an active smoke control system that are not provided with fire dampers penetrate rated and non-rated floors.
3. Provide pipe or duct sleeve for all penetrations. Space between pipe or duct and sleeve shall not exceed the UL listing of the penetration.
  4. Fill annular space between pipe and sleeve, or between duct and sleeve on non-dampened penetrations, with approved material.
  5. Depth of material shall be in accord with laboratory tests for 1, 2, or 3 hour rated assemblies.
  6. Damming material may be temporary non-fire approved, or permanent fire-approved. Where permanent fire-approved damming material is used depth of fire and smoke stopping material may be decreased in accord with manufacturer's recommendations. Temporary damming material shall be removed after installation of fire and smoke stopping material.
  7. Seal all gaps or voids in cured foam with material to match the fire and smoke stopping material.
  8. Trim excess cured foam from around all openings and leave smooth, flush surface.

C. Electrical Requirements:

1. Electrical apparatus, devices, controls, etc., required but not specified in detail in this Division shall conform to Division 16 - ELECTRICAL.
2. Except as otherwise detailed or specified, all power wiring required to operate electrical devices and equipment furnished in this Division will be provided under Division 16 - ELECTRICAL.
3. Control and interlock wiring required for all electrical devices and equipment furnished in this Division is specified under Section 15058 - CONTROL WIRING.
4. Motor driven equipment provided under this Division shall be provided with motors as specified in Section 15055 - MOTORS.
5. Starters shall be furnished under Division 15 for installation under Division 16 - ELECTRICAL. Starters shall be as specified in Section 15057 - Adjustable Frequency Drives.
6. Starters, except where specified to be furnished with the equipment or for motors having adjustable frequency drives, shall be provided in Motor Control Centers under Division 16 - ELECTRICAL.

D. Concrete Work:

1. Concrete pads and curbs for supports of equipment shall be a minimum of 4" high with chamfered edges and sized for approved equipment. Furnish drawings to Division 3 Contractor.
2. Surfaces of concrete shall be troweled smooth. When forms are removed, fill voids with cement and rub smooth with rubbing stone.
3. Do not pour concrete when ambient temperature is less than 40°F, and falling.

E. Excavation, Trenching, and Backfilling:

1. Definitions:
  - a. Satisfactory material includes all materials except those classified

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"unsatisfactory", "unyielding" or "unstable".

- b. Unsatisfactory material includes those materials containing roots, organic matter, trash, debris, frozen materials, stones larger than 3 inches in any dimension, and materials classified by ASTM D 2487 as OL, OH, and PT.
- c. Unyielding material consists of rock and gravelly soils with stones greater than 3 inches in any dimension, or as defined by the pipe or tank manufacturer, whichever is smaller.
- d. Unstable material consists of material too wet to properly support the pipe or tank.
- e. Select granular material consists of well- graded sand, gravel, crushed gravel, crushed stone, or crushed gravel, crushed stone, or crushed slag composed of hard, tough, and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve, and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 3 inches, or the maximum size recommended by the pipe or tank manufacturer, whichever is smaller.

2. Excavation, trenching, and backfilling for site utility piping systems is specified in DIVISION 2 - SITEWORK.

F. Placing of Equipment:

1. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.
2. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.
3. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.
4. Exercise caution during equipment placing operations to insure that structure is not overloaded.
5. Do not move heavy equipment across floor or roof of insufficient load bearing capacity to support such equipment. Provide bracing or shoring as required, or use crane to place equipment directly on permanent and finished support.

END OF SECTION 15050

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SECTION 15051  
ADJUSTING, BALANCING AND SYSTEM TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Checking installation for conformity to design.
- B. Checking each piece of equipment for proper installation and operation.
- C. Balancing air and water distribution systems to provide design fluid quantities.
- D. Measuring and recording of fluid quantities.
- E. Electrical measurement.
- F. Verification of performance of all equipment and sequence of operation of automatic controls.
- G. Checking sound levels and vibration isolators for proper function and measurement and correction where a problem or question of acceptability exists.
- H. Recording and reporting results on sub-contractors standard report forms and on commissioning data sheets where these have been provided.

1.3 REFERENCES

- A. Air Diffusion Council (ADC) 1062R3 Equipment Test Code
- B. Associated Air Balance Council (AABC)  
National Standards for Field Measurements and Instrumentation, Total Balance System Balance, Air Distribution - Hydronic Systems, Volume 1.

1.4 SUBMITTALS

- A. Submit in accordance Division 1 Requirements.
- B. Submit complete description of procedures, instrument calibration and qualifications of personnel actually doing testing and balancing on this project prior to beginning of any balancing.
- C. Submit schedules of test data readings in organized, schematic, tabulated format. Include schematic drawing showing location of all readings.
- D. Submit as-built drawings showing locations of all readings.

1.5 QUALITY ASSURANCE

- A. Adjusting, balancing and testing procedures and compilation of test data shall be performed by a Certified Test and Balance Engineer or by personnel trained and super-

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vised by a Certified Test and Balance Engineer.

- B. Test and balance personnel shall be qualified to perform testing and balancing in accordance with AABC or NEBB procedures.

1.6 TOLERANCES

- A. Balance final fluid flow (air and water) to within plus or minus 5 percent of specified quantities. Caution is urged on systems where diversity has been taken and the total flow exceeds the equipment capacity. In this case, the system must be sectioned as necessary to get proper terminal flow.

1.7 GENERAL COMMENTS

- A. Water Balance: Readings from venturi flow meters, or automatic pressure independent flow control devices will be given highest priority as to accuracy. Where neither is specified pump curves and chiller or boiler pressure drops are to be correlated to establish flow. Pressure drop across coils or chillers is to be used to proportion flow. Volt and ampere readings will be used as checks. Temperature data will be used only as a performance check and not for balancing.
- B. Air Balance: Readings from a pitot tube traverse will be given highest priority as to accuracy. Terminal flow shall be as taken from the terminal DDC flow readings. Outlet flow as established by flow hood will be used to pro-rate air flow. Pressure readings as well as voltage and ampere readings will be used for check purposes only. Temperature readings will be used as a check against performance.
- C. All readings shall be cross-checked for accuracy. These cross-checks shall be tabulated within the report.

PART 2 – PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Review drawings and specifications with regard to adjusting and balancing.
- B. Additional balancing devices which, in the opinion of the TAB sub-contractor, would aid in the adjusting and balancing of the systems shall be brought to the attention of the contractor prior to bid time so that the contractor may make allowances to cover the provision of these additional devices in the original bid.
- C. Minor modifications in system design which, in the opinion of the Contractor, would aid in the adjusting and balancing of the systems may be provided subject to approval of the Owner's Representative at no additional cost to the Owner. Design modifications shall not lessen the operating efficiency of the systems.

3.2 WATER BALANCE

- A. Ascertain that piping systems have been cleaned, flushed, drained and properly refilled and that all strainer baskets have been removed, cleaned and properly reinstalled prior to beginning water balancing procedure.
- B. In the event that TAB work is started prior to the completion of the water treatment portion of work, the TAB contractor shall make a random recheck as directed by the

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Owner's Representative. The results of this re-check shall be included in the final report.

- C. For constant flow pumping systems using three way control valves and using automatic, pressure independent system of flow control for hot water heating and chilled water system coils. Before balancing the system, the following procedure shall be executed.
  - 1. With one pump running and all manual and automatic control valves open, record gpm stamped on each automatic flow control device and read and record the pressure drop across those which have dual pressure taps as well as across each coil or heat exchanger.
  - 2. With pump running as described above and all manual and automatic control valves open read and record pressure drop across each pump at full flow. Also read and record pressure drop at shut off. Plot these points on the submitted pump curves using the sum of the flow control device gpm as the total system flow.
  - 3. If the pressure drop across all flow control device exceeds 3 psig, the pump has excess head capability. If the drop across all of the devices equal or exceed 6 psig then the pump impeller may require trimming to keep energy use to a minimum. Submit this data to the Owners Representative for early review if this excess head condition exists, prior to proceeding with balancing to determine if an impeller trim is warranted.

### 3.3 AIR BALANCE

- A. Check system visually and audibly for leakage and proceed with balancing as outlined by AABC or NEBB.
- B. Balance for full flow shall be based on dirty friction loss across the filters. Artificially blank-off sections on a uniform pattern as required to simulate this condition.
- C. Variable Volume Systems:
  - 1. With supply fan running at 100% speed and all terminals calling for full air flow, read and record flow and fan suction and discharge static pressure readings. Pressure readings shall be obtained using procedures outlined in AMCA Publication 203-90 Field Performance Measurement of Fan Systems. Plot on submitted fan curve.
  - 2. Set flow at each terminal for maximum values as indicated in terminal schedule using hand held operators terminal (HHOT) furnished with the terminal controls. Provide actual measured outlet flow to temperature controls sub-contractor for setting calibration constants in DDC controls. Normally diversity is taken in the fan selection. Close other terminals as required to get full flow as required for balancing. Pro-rate terminal flow to diffusers.
  - 3. Set minimum flow to values as indicated in terminal schedule.
  - 4. Where applicable, adjust return fan for specified differential flow. Record fan signal fan speed and other data at full flow and at minimum flow.
  - 5. Record all data on terminals and supply and return fan including voltage and amperage on primary air fans and return fans at full flow.

### 3.4 AIR HANDLING UNIT PERFORMANCE TESTING

- A. Recognizing that it will be unlikely that the performance testing will be done on a design day, cooling and heating coil performance shall be recorded as follows.
  - 1. With fan delivering design air flow and control valves open to deliver design water flow, read and record entering and leaving drybulb and wetbulb

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temperatures, air and waterside flow, pressure loss values and water temperatures.

2. Through the contractor, request performance data from the equipment supplier based on the measured air flow and entering air temperatures and measured water flow and entering water temperature. Submit this data with test data for review.

### 3.5 REFRIGERATION SYSTEM PERFORMANCE TESTING

- A. Recognizing that it will be unlikely that the performance testing will be done on a design day, refrigeration system including heat rejection equipment performance shall be recorded as follows.
  1. With pumps delivering design water flow, read and record entering and leaving water conditions, pressure losses, evaporator and condenser temperature and pressures, oil pressures and temperatures and compressor motor KW or amps.
  2. Through the contractor, request performance data from the equipment supplier based on the measured flow, leaving chilled water temperature, entering condenser water temperature or condensing temperature and calculated tonnage. Submit this data with test data for review.
  3. With heat rejection equipment delivering design air flow, read and record entering and leaving air drybulb and wetbulb temperatures and air flow, water temperature and condensing temperatures as appropriate.
  4. Through the contractor, request performance data from the equipment supplier based on the measured air flow and entering air temperatures and measured water flow and entering water temperature. Submit this data with test data for review.

### 3.6 CONTROLS ADJUSTMENT

- A. Check the automatic temperature controls to ascertain that the specified sequence of operation is occurring. Record thermostat set point and room conditions in each space. This includes checking each terminal box to ensure that supply air goes to minimum position before heat comes on.
- B. Compare temperature of space (taken with test instrument) to temperature read by thermostat or temperature sensor. Tabulate results.
- C. In cooperation with the controls contractor, set adjustments of automatically operated dampers to operate as specified, indicated, and / or noted.
- D. Check all controls for proper calibrations, and list all controls requiring adjustment by control installers.

### 3.7 CONTRACTOR'S RESPONSIBILITIES

- A. Final testing and balancing of the HVAC systems shall be performed as specified in this section. It is the responsibility of the Contractor to be completely familiar with all the provisions and responsibilities of the Balancer, and to provide such certification, cooperation, and support required.
- B. The Contractor shall repair all deficiencies noted by the Balancer in a timely manner. The Balancer will notify the contractor in writing, on a daily basis, of any deficiencies discovered and Contractor will notify the Balancer immediately, in writing, upon completion of the repairs. The cost for extra re-testing by the Balancer due to un-repaired items that were certified as repaired, will be the responsibility of the Contractor.

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The final testing and balancing report will contain no punch list items. All deficiencies will have been corrected prior to submission of the final report. Preliminary reports are not to be submitted to the Owner.

C. The Contractor shall:

1. Allow adequate time in the construction schedule to perform the Testing and Balancing work.
2. Notify the Balancer upon commencement of work related to the HVAC system.
3. Provide required shop drawings and equipment data.
4. Provide test openings as required for testing and balancing HVAC systems.
5. Provide updated job schedule and timely notice prior to scheduled events.
6. Provide test openings and temporary end caps or otherwise seal off ends of ductwork to permit leakage testing prior to installation of diffusers, grilles, and similar devices.
7. Make preliminary tests to establish adequacy, quality, safety, completed status, and satisfactory operation of HVAC systems and components. The systems shall be free of electrical grounds and short circuits.
8. Perform duct leakage tests, in the presence of the Balancer, on all supply, return, outside air make-up, and exhaust air systems.
9. Within the intent of the contract documents, provide, at the request of the Balancer, all equipment, material, supplies, workmen, and supervisions necessary to provide a satisfactory, operating system.
10. During the test and balance period, operate all HVAC equipment as necessary to permit systems to be tested and balanced as fully operating, functional systems.
11. Work harmoniously with the Balancer, providing all courtesies normally extended to professional consultants.
12. Perform all work necessary to make ceiling plenums air-tight and functional.
13. Remove and replace ceilings as necessary to permit test and balance operations.
14. Remove and replace equipment, lights, or other items which obstruct testing and balancing operations. Where equipment, lights, or other items will interfere with future adjustments of the HVAC system, such equipment, lights, or other items shall be relocated by the Contractor, as directed by the Architect.
15. Provide completed start-up forms on each piece of equipment.
16. Replace belts and drives as required for proper balancing. Drives shall be adjusted and aligned by the Contractor to prevent abnormal belt wear and vibration.
17. Adjust fan speed as required not to exceed RFLA of motor.
18. Open all manually adjustable dampers and test dampers for smooth, vibration-free operation.
19. Verify that all controls are installed and operating in accordance with the sequence of operation.
20. Before requesting final testing and balancing, submit signed statement that HVAC systems are installed, adjusted, fully lubricated, operating satisfactorily, and are ready for use.

- D. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater) operationally air-tight, with no more than 2% leakage for duct systems rated at 2" w.c. pressure class, and 1% leakage for systems exceeding 2" w.c. pressure class. Leakage test to be performed by Contractor with all air device openings and fan connections sealed airtight. Test the systems prior to applying any insulation or concealing in soffits or chases. Use a portable fan capable of producing a static pressure equal or greater than the duct test pressure. This fan to have a flow measuring assembly consisting of a straight section of duct with



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an orifice plate, pressure taps, and a calibrated performance curve for determining leakage rates.

1. Test each section equal to the external static pressure indicated for that fan or air handler with the portable fan assembly. After the fan achieves that steady state design pressure, record the air flow quantity across the orifice and the percent of design air flow. If the test fails, the Contractor shall reseal and retest at no additional cost to the Owner.
2. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.
3. Submit duct leakage reports to the Balancer and the Engineer for their review and approval.

3.8 TEST DATA SCHEDULES

- A. Submit typewritten schedules of test data readings.
- B. Schedules shall record the specified reading, the first reading taken and the final balanced reading for the following items.
- C. Where Commissioning Forms are provided, equipment data shall be recorded on these forms for comparison with submitted design data.
- D. Witness and record the testing of the ductwork for leakage to insure proper sealing. The Balancer shall randomly select sections of the completed duct system for testing. The sections selected shall not exceed more than 20% of the measured linear footage of supply, return, exhaust or plenum duct length. All selected ductwork shall be leak tested in accordance with SMACNA. Maximum allowable leakage at any tested section shall not exceed 2% of the total air. If any of the selected duct sections exceed the specific leakage allowance, those sections shall be repaired by the Contractor and retested by the Balancer. If initial testing exceeds specification allowance, testing of all remaining duct ductwork shall be required at the Contractor's expense. All additional costs for duct leak repair and retesting shall be the responsibility of the Contractor.
- E. Advise Contractor in writing of all ductwork that shall be repaired to reduce air leakage. Retest to confirm minimum allowable leakage. The cost of retest of failed systems will be the responsibility of the Contractor.
- F. In the case of off season performance testing of air handling equipment and refrigeration equipment, include manufacturer's projected performance for comparison.
  1. Motors:
    - a. Designation.
    - b. Nameplate HP, voltage and full load amperes.
    - c. RPM.
    - d. Motor amperes and voltage under operating conditions.
    - e. For belt drive applications, motor amperes and voltage under no load condition.
  2. Fans:
    - a. Designation.
    - b. Nameplate data.
    - c. RPM.
    - d. Static pressure, inlet and discharge.

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- e. CFM from pitot tube traverse of discharge duct.
  - f. Final pitot tube traverse sheets showing all readings.
3. Main and Sub-main Ducts:
- a. Designation and location.
  - b. CFM from pitot tube traverse.
  - c. Final pitot tube traverse sheets showing all readings.
4. Variable or Constant Volume Boxes:
- a. Designation.
  - b. Nameplate data.
  - c. Static pressure, entering and leaving air.
  - d. CFM, maximum setting on regulator.
  - e. CFM, minimum setting on regulator. Note: If there is no minimum flow shown on the schedule on the drawing then the unit is to go to full shut-off at the minimum setting.
  - f. CFM, maximum as measured by flow hood readings on air outlets and CFM maximum and minimum measured by pitot tube traverse of discharge duct on 10% of boxes. Note: if these readings are not within  $\pm 10\%$  of setting on boxes advise contractor and engineer so that a decision can be made on how to proceed with the air balance.
  - g. Final pitot tube traverse sheets showing all readings.
5. Air Outlets and Inlets:
- a. Room designation.
  - b. Type of outlet.
  - c. Design CFM.
  - d. Measured CFM.
  - e. Method of measurement.
  - f. All final measurement readings.
6. Pumps:
- a. Designation.
  - b. Nameplate data.
  - c. GPM (unbalanced).
  - d. Pressure, suction and discharge (unbalanced).
  - e. Suction and discharge pressure with discharge valve closed (shut-off).
  - f. GPM (final balance).
  - g. Pressure, suction and discharge (final balance).
  - h. Pressure entering and leaving strainer.
7. Coils - Water:
- a. Designation.
  - b. Nameplate data (if available).
  - c. Pressure entering strainer valve and leaving flow control device.
  - d. Pressure entering and leaving flow control device where two taps are provided.
  - e. Temperature entering and leaving water.
  - f. Static pressure, entering and leaving air.
  - g. Dry bulb and wet bulb temperature, entering and leaving air (4 readings at quarter points where coils are over 20 sq.ft. F.A.)
  - h. CFM over coil including all final readings used to obtain cfm.

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- i. GPM from flow regulator nameplate.
8. Chillers - Air Cooled:
- a. Designation.
  - b. Nameplate data.
  - c. Refrigerant type.
  - d. Pressure, entering and leaving chilled water.
  - e. Temperature, entering and leaving chilled water.
  - f. Pressure and/or temperature, evaporator, refrigerant.
  - g. Pressure and/or temperature, condenser refrigerant.
  - h. Total unit amperes and volts, each phase.
  - i. Calculated GPM, chilled water.
  - j. Calculated power, KW.
9. Kitchen Exhaust Hoods:
- a. Designation.
  - b. Nameplate data.
  - c. Exhaust air CFM, from pilot tube traverse.
  - d. CFM and velocity in capture area.
  - e. All final readings used to determine cfm.

3.9 OPERATING TESTS

- A. Operate systems to demonstrate that systems have been properly adjusted and balanced, and to demonstrate that the systems' performance conforms with the intent of the specifications and drawings.
- B. The balancing contractor shall make available to the Owner's operating personnel a Certified Test and Balance Engineer for a minimum of 16 hours, two working days, not necessarily consecutive, with all necessary equipment to demonstrate that all systems operate as intended and that the balancing reports are accurate.
- C. This demonstration will occur after the balancing contractor has submitted his reports to confirm that all systems or portions of the systems that coincide with the building's occupancy schedule, are adjusted and balanced.
- D. Conduct tests with natural building heating and/or cooling loads for a minimum 4 hours duration.

END OF SECTION 15051

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SECTION 15055  
MOTORS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 WORK INCLUDED

- A. Motors for equipment furnished under Division 15.

1.3 STANDARDS

- A. NEMA Publications MG-1, MG-2, MG-13.

1.4 QUALITY ASSURANCE

- A. Motor efficiencies in accordance with IEE Standard 112 Method B as defined by NEMA MG1-1.23 a and b.

1.5 SUBMITTALS

- A. Submission for acceptance is required. All three phase motors are based on NEMA Premium™ efficiency motors as described below by the minimum allowable efficiency. As a result, all motor starting codes are based on Code letter F or greater as defined by NEC Article 430. In the event that a manufacturer provides a motor with a code letter less than F, the overcurrent protection of the motor shall be coordinated with the Division 16 Contractor to comply with NEC Article 430.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. A.O. Smith/Century E-Plus
- B. Baldor Electric Company, Premium Efficiency.
- C. Emerson Electric Company, U.S. Electrical Motors Div., Premium Efficiency Type 'DE' & 'RE'.
- D. The Louis Allis Company, High Efficiency.
- E. General Electric Company, Premium Efficiency Energy Saver®
- F. Reliance Electric Manufacturing Company, XE™ Premium Efficiency Motors.

2.2 FABRICATION

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A. 3/4 HP and Larger Horsepower Motors:

1. NEMA Premium™ efficiency type having the following minimum efficiencies:

Minimum Nominal Full-Load Motor Efficiency (%)						
	Open Motors			Totally Enclosed		
Number of Poles	2-Pole	4-Pole	6-Pole	2-Pole	4-Pole	6-Pole
Speed (RPM)	3600 RPM	1800 RPM	1200 RPM	3600 RPM	1800 RPM	1200 RPM
HP						
0.75	---	85.5	---	---	85.5	---
1	82.5	85.5	82.5	77.0	85.5	82.5
1.5	84	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93	91.7	91.0	92.4	91.7
20	91	93	92.4	91.0	93.0	91.7
25	91.7	93.6	93	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93	94.7	94.1	93.0	94.5	94.1
60	93.6	95	94.5	93.6	95.0	94.5
75	93.6	95	94.5	93.6	95.4	94.5
100	93.6	95.4	95	94.1	95.4	95.0
125	94.1	95.4	95	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95	95.8	95.4	95.4	96.2	95.8
250	95	95.8	95.4	95.4	96.2	95.8
300	95	95.8	95.4	95.4	96.2	95.8

2. Open drip proof, except motors located outdoors to be TEFC or as otherwise specified.
3. Continuous duty, 40°C ambient.
4. Regreasable ball bearing design.
5. Speed/Torque curves shall be NEMA Design B so that overload protection provided by standard motor starters will be adequate to prevent over-heating during stall or slightly prolonged motor acceleration.
6. Class B insulation, except motors for variable speed drive application to be specially built for Adjustable Frequency Drive (AFD) duty and include Class F insulation and be suitable for operation down to 10% on fan and pump applications.
7. Assembly to meet application.
8. 1.15 service factor.
9. Suitable for starter type as scheduled on drawings.
10. Slide bases as required.
11. 60 Hz. terminal box large enough to accommodate the required conduit and wiring.

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12. 200, 208, 230 or 460 volt, 3 phase as scheduled.

B. Fractional Horsepower Motors:

1. Permanent split capacitor.
2. 115 volt, 1 phase, 60 Hz.
3. Thermally protected.
4. Other features of motors supplied as an integral part of a factory assembly shall be acceptable as the manufacturers standard based on acceptance of the assembly as a whole.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motors:

1. Install in accordance with requirements of the duty.
2. Lugs to be provided under this Division.
3. All motors shall have overload protection as required by NEC. Any motor without integral protection shall have a starter that provides overload protection furnished by Division 15.

END OF SECTION 15055

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SECTION 15057  
ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Adjustable frequency drive units (AFD) for all motors identified as operating at variable speed.

1.3 QUALITY ASSURANCE

- A. All adjustable frequency drives and bypass assemblies and control panel enclosures must be the product of a single manufacturer.
- B. AFD shall be UL or ETL listed. Components used in all options shall be UL listed. The entire AFD and bypass assembly shall be U.L. marked with a short circuit current rating of at least 100,000 amperes. The VFD short circuit rating shall be posted in the operating instructions or on the product label. This shall be in compliance with the UL listing and rating requirement.
- C. The AFD shall be designed to meet the power line transient conditions defined within ANSI/IEEE C62.41-2002 (or Latest Edition) and shall have a voltage withstand rating of 6 KV in accordance with UL 1449.
- D. AFD shall be in certified for with FCC emission limits for Class A computing devices. If required to meet these limits, isolation transformers, and/or line filters shall be provided.
- E. Ambient noise generated by the AFD shall be limited to an amount equal to 3 dbA greater than the fan or pump system noise level at design rpm. If acoustic enclosures are required to meet these limitations provide same with the AFD.
- F. AFD manufacturer shall submit an analysis to certify that the drive, when installed in the electrical distribution system shown on the Contract Documents is in compliance with the requirements of IEEE 519 – 1992 (or Latest Edition). The Point of Common Coupling (PCC) shall be defined as the secondary lugs of the Utility Company Transformer. The transformer impedance shall be 5.75% with the appropriate short circuit current based on this value.
- G. AFD and option design and construction thereof shall comply with all applicable provisions of the latest National Electrical Code.
- H. Power components shall undergo burn in to ensure product function. Circuit boards shall be tested under thermal cycling and the complete unit shall be tested under full load conditions to ensure maximum product reliability.
- I. A Factory Authorized Service Engineer is to be provided for start up which shall include verification of proper installation and wiring. Inspect all components, circuit boards and control wiring. Ensure proper power source and control signal. Apply power and provide full operational testing and calibration. Also provide training for owner's operators.

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- J. Provide full three year on-site parts and labor warranty including travel time and expense. Warranty period shall begin at date of substantial completion.
- K. AFD's shall be fully protected during the duration of construction of the project. Units shall be covered to protect from all dirt, dust and debris. Contractor will be responsible for replacing any unit that has dirt, dust or debris infiltration into the unit.
- L. The supplier shall offer a service support group which shall be able to provide the following additional services; not included in this contract:
  - 1. Emergency service calls.
  - 2. Overnight service parts.
  - 3. Service contracts.
  - 4. In-plant training of client personnel in basic troubleshooting.
  - 5. Coordinate enrollment of client personnel in factory-held service schools.

1.4 SUBMITTALS

- A. Submission for acceptance is required. Submittal shall show compliance with all paragraphs and statements listed in part 2 below.
- B. A complete harmonic analysis showing compliance with IEEE 519 - 1992 (or Latest Edition) shall be provided with the submittal as defined in paragraph 1.3 above.
- C. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- D. Refer to Division 1 requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Adjustable Frequency Drive Units:
  - 1. ASEA Brown Bovari (ABB)
  - 2. Century (MagnaTek)
  - 3. Cutler Hammer
  - 4. Danfoss/Graham
  - 5. Hitachi
  - 6. Reliance Electric
  - 7. Square D
  - 8. Trane
  - 9. SSD Drives, Inc.
  - 10. Toshiba
  - 11. York

2.2 EQUIPMENT REQUIREMENTS

- A. Adjustable Frequency Drive:
  - 1. The adjustable frequency drive shall convert either 208/230 or 460 volt  $\pm 10\%$ , three phase, 60 HZ ( $\pm 2$  HZ) utility power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5% to 105% of base speed.
  - 2. The adjustable frequency drive (AFD) shall produce an adjustable AC voltage/frequency output for complete motor speed control using transistorized



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sinecoded PWM technology, and an input power factor near unity over the entire speed range. The AFD shall not produce excessive or objectionable motor acoustical noise. The AFD shall not induce voltage line notching back to the utility line and total harmonic distortion (THD) shall not exceed the limits set in IEEE Std. 519 -1992 (or Latest Edition) when installed in the electrical distribution system shown on the Contract Documents. The AFD shall be automatically controlled by a grounded electronic control signal.

3. The AFD shall be self contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0° and 40°C except where located outdoors enclosure to be NEMA 3R or 4X watertight and dust-tight enclosure, depending on the manufacturers offering. The entire AFD assembly shall be mounted in a common enclosure requiring only a power in and a power out connection.
4. The AFD maximum output current rating shall be as follows:

Horsepower (HP)	FLA @ 208 V	FLA @ 460 V
5	16.7	7.6
7-1/2	24.2	11.0
10	28.0	14.0
15	46.2	21.0
20	59.4	27.0
25	----	34.0
30	----	40.0
40	----	52.0
50	----	65.0
60	----	77.0
75	----	99.0
100	----	124.0

5. AFD shall be a minimum of 97% efficient at 100% rated output power, 60 HZ.
6. The AFD shall have the following basic features:

- a. Operator control interface.
  - (1) Hand/Off/Auto operator switch.
  - (2) Panel mounted digital display capable of indicating unit status, frequency and fault diagnostics, including overcurrent, overvoltage, overheating, ground fault or short circuit.
- b. Electronic control follower board, 0-5 VDC, 0-10 VDC or 4-20 mA or 0-135 ohms (coordinate requirement with controls contractor).
- c. Minimum/maximum adjustable speeds (Minimum speed factory set at 12 HZ, maximum speed factory set at 60 HZ, may vary based on application).
- d. Manual speed potentiometer control for use when AFD is in manual control mode.
- e. Adjustable linear timed acceleration and deceleration for soft starting/stopping (adjustable from 1-300 sec) recommended range 20-60 seconds depending on inertial load. Factory set at 60 seconds.
- f. 3-80 HZ controlled speed range (factory set at maximum frequency of 60 HZ).
- g. Output terminals for remote frequency meter and ammeter.
- h. RFI/EMI filter.
- i. Manual bypass circuit with three contactors to provide full speed starter operation for motors 100 HP and less and an electronic, solid state, full-wave, soft-start controller for all motors 125 HP and larger for operation in the event of AFD electronics failure complete with disconnect and overload protection in all three phases. Provide a three-phase power

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monitor as manufactured by Time Mark Corporation Model 258 or equal, providing solid state protection by opening starter for loss of any phase, low voltage or any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage. Monitor shall be UL recognized.

- j. Line circuit breaker disconnect (door-interlocked) with current limiting fuses on the line side of the circuit breaker having a minimum AIC rating of 200,000 Amps. The disconnect switch shall have a minimum short circuit rating of 100,000 amps.
  - k. Provide line impedance reactors to the power line to reduce the total harmonic distortion (THD) level to that allowed by IEEE 519-1992 (or Latest Edition). If the harmonic distortion level required by IEEE 519-1992 (or Latest Edition) can be met without these devices, they may be omitted.
  - l. Isolation transformer with electrostatic shields for optimum noise protection and phase shifting capability shall be provided where the addition of line impedance reactors will not lower the total harmonic distortion (THD) level to that allowed by IEEE 519 – 1992 (or Latest Edition). If the harmonic distortion level required by IEEE 519 - 1992 (or Latest Edition) can be met with only line reactors, then phase shifting isolation transformers may be omitted.
7. The AFD controller shall include the following protective circuits/features:
- a. Current limit shall be provided at 100% of the motor FLA. If current exceeds 100% of the motor current, the AFD will slow down the motor. If the current continues to rise the AFD shall shutdown on overcurrent. Current limit will be adjustable by qualified service personnel for application of AFD to smaller than nameplate motors.
  - b. Current limit/soft stall feature - current limit/soft stall allows continuous operation while in an overload condition. It limits the current by slowing down the frequency. The soft stall feature will be field set and the current limit adjusted to 100% of the motor FLA or drive FLA whichever is smaller.
  - c. Instantaneous electronic trip - automatically safely shutdown motor if:
    - (1) Current exceeds 200% of design.
    - (2) Phase-to-phase output short circuit occurs.
    - (3) Phase-to-ground output short circuit occurs.
    - (4) Phase loss occurs.
  - d. The AFD shall be programmable to provide restart automatically, if desired, when input line returns to normal in the event of:
    - (1) Intermittent power outage.
    - (2) Phase loss.
    - (3) Overvoltage shutdown.
    - (4) Intermittent voltage spike.
  - e. Insensitive to incoming power phase.
  - f. Line-to-line fault protection.
  - g. Line-to-ground short circuiting and accidental motor grounding protection.
  - h. Electronic overload protection.
  - i. Over-temperature protection.
8. The AFD shall be designed and constructed to operate within the following

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service conditions:

- a. Elevation up to 3300 feet without derating.
- b. Ambient temperature range - 0°C to 40°C.
- c. Atmosphere - non-condensing relative humidity to 90%.
- d. A-C line voltage variation - 10% to +10%.
- e. A-C line frequency variation  $\pm 2$  HZ.

- 9. Bases of Design: Danfoss FC102 or Trane TR200, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Adjustable Frequency Drive:

- 1. Furnish adjustable frequency drive for each motor identified as requiring an adjustable frequency drive or variable speed operation.
- 2. Receive, unload and deliver drives to electrical contractor on job-site for storage, uncrating and installation by Division 26.
- 3. Furnish all necessary wiring diagrams to electrical contractor for installation and power wiring.
- 4. Coordinate the purchased equipment with the motor served and with the automatic temperature control system, paying specific attention to the signal sent and received and the ground source.
- 5. Start-up shall be by a factory trained field service engineer. Start-up shall be done with the cooperation of the controls contractor. The minimum speed shall be set for 20% at the AFD. The control signal shall be full scale so that the minimum speed will be 20% (adjustable).
- 6. AFD to be mounted where indicated on the drawings or within sight of the motor controlled.
- 7. Where a remote disconnect is provided for a motor controlled by an adjustable frequency drive, coordinate with the supplier of the disconnects to ensure that a late make, early break auxiliary contact rated for ten amps continuous duty is provided on the disconnect. This auxiliary contact must be wired into the AFD start circuit to ensure shut-down of the AFD in the event of the disconnect being opened.
- 8. AFD may be mounted directly to masonry, CMU or concrete walls using appropriate fastening methods, including back plates. When the wall is an exterior wall or any wall where condensation may occur, provide appropriate stand-off, i.e., (Uni-strut channel).
- 9. AFD may be mounted directly to equipment such as factory or field built AHU. In this case, through bolts and backing plates along with an appropriate stand-off shall be used. Seal all holes. Self-tapping screws with exposed ends will not be acceptable.
- 10. When AFD is required to be located in areas where walls are not available, provide a Unistrut type frame securely mounted to floor adequately braced to form a rigid mounting surface.
- 11. AFD shall be generally mounted with the center of the unit at 60" above the finished floor. Service clearance shall be provided in accordance with the National Electric Code and under no circumstances less than the following:

<u>Voltage to Ground</u>	<u>Minimum Clearance Distance</u>
110V or 120V	3'-0"
208V, 220V, 240V or 277V	3'-6"

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460V or 480V	4'-0"
Greater than 480V	5'-0"

12. Adjustable frequency drives shall be accessible.
13. Provide housekeeping pad for all floor mounted adjustable frequency drives.

END OF SECTION 15057

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SECTION 15058  
CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Provisions of Section 15010 - Mechanical General Provisions, shall be made an integral part of this section.
- C. Provisions of Section 16010 - Electrical General Provisions, shall be made an integral part of this section.

1.2 WORK INCLUDED

- A. Building Control System Wiring.
- B. Control Circuit for Adjustable Frequency Drive Alternator.

1.3 DEFINITIONS

- A. Control Wiring: All wiring, high or low voltage other than power wiring, required for the proper operation of the mechanical systems.
- B. Power Wiring: All line voltage wiring to the mechanical equipment. Line voltage which also serves as a control circuit, such as a line voltage thermostat, or involves interlocking with a damper, shall be considered control wiring.

1.4 QUALITY ASSURANCE

- A. All work will be in accordance with the requirements of the National Electrical Code.

1.5 SUBMITTALS

- A. Submittals are not required.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. All material used in the completion of the wiring under this section will comply with the requirements of Division 16 Electrical.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cooperate completely with the contractor for Division 16.
- B. Provide all conduit, wire and accessories necessary to complete the control wiring as specified under WORK INCLUDED.
- C. Because of variations in requirements from manufacturer to manufacturer, all details may

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not be included in the Contract Documents. This sub-contractor must obtain approved coordinated wiring diagrams before proceeding with the control wiring.

- D. All control wiring shall be properly installed in an approved raceway system or when allowed, run exposed in concealed spaces. All control wiring run in exposed areas shall be in an approved raceway unless otherwise noted.
- E. Control wire run exposed shall be neatly bundled and routed parallel and/or perpendicular to building structure or equipment casing. Routing of wire shall be so that it does not interfere, chafe or obstruct service or maintenance of the equipment served.
- F. Exposed control wire shall be properly secured and/or supported within equipment enclosures. Cable shall be secured on no greater than 18" centers.
- G. All openings made for the passing of control wire shall be properly bushed to prevent chafing. Hole size shall be suitable for the quantity of wires or tubing passing through while allowing for ease of pulling and future expansion. Oversized holes beyond these requirements are not allowed.
- H. Holes made within air handling equipment which may allow the transfer or bypassing of air shall be properly sealed after wire is pulled. Expanding foam sealant and proper backing material will be acceptable. Seal shall be suitable for maximum unit operating pressures.
- I. Attachments of control devices, raceway and cable supports shall be made with proper attachments. Self-drilling screws which result in exposed end will not be acceptable. Bolts and nuts shall be used with bolt head exposed to view. All fasteners located where exposed to weather or moisture shall be stainless steel or cadmium plated.
- J. Any opening, holes or cuts in equipment enclosures or building structure not used shall be neatly sealed. On equipment, the seal or patch shall be of similar material sealed and painted to match.
- K. The control contractor shall clean all unused or scrap material from the equipment enclosure.
- L. All control wire shall be identified by proper cable identification methods. Verify how cables shall be labeled with the Owner's Representative prior to the start of work. All termination shall be labeled and labels clearly visible.
- M. All control devices, cabinets, equipment and raceways shall be labeled. Verify how the hardware shall be labeled with the Owner's Representative prior to the start of work.
- N. Splices in control wire are not allowed unless the length of run is too great to allow for a continuous run. When splices become necessary, they shall be solder connected with heat shrink tubing. When raceway is used, all splices shall be in junction boxes.
- O. Control devices (i.e., flow switches), connected to cold equipment where the possibility of condensation may occur shall be vaporproof type. The connecting conduit shall be properly sealed with spray type foam after the wires are pulled through. If this is not possible, a weatherproof junction box shall be close mounted to the device to allow for proper moisture sealing. Conduit connections shall be sealed with a silicon type caulk/sealant.
- P. All control devices or wiring located exposed to weather or moisture shall be in an approved raceway system. This system shall be properly supported and sealed to

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prohibit moisture convection or transfer. Provide flexible conduit similar to seal tight for connection to all equipment. EMT and set screw fittings are not acceptable. All exterior raceway shall be IMC (Intermediate Metallic Conduit) or better with threaded fittings.

- Q. Where a disconnect switch is mounted between an adjustable frequency drive and the motor, the disconnect must have a late make, early break auxiliary contact. This contact shall be wired into the AFD control circuit so that the control circuit is disconnected before the power circuit it broken.

END OF SECTION 15058

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SECTION 15060  
PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 WORK INCLUDED

- A. Chilled Water Piping (CHS/CHR)
- B. A/C Unit Condensate Drain (CD) Piping.

1.3 DEFINITIONS

- A. Pipe sizes given in this document are nominal.

1.4 QUALITY ASSURANCE

- A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.
- B. Each item provided under this section shall meet the requirements for that item as installed and used, in accordance with the following standards:
  - 1. Metallic Piping Systems employing mechanical joints and grooved-end pipe - ASME/ANSI B-31.9
  - 2. Refrigeration Piping - ASME/ANSI B31.5
  - 3. All other metallic piping - ASME/ANSI B31.1
- C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.
- D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.
- E. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.5 SUBMITTALS

- A. All submittals shall be made in accordance with Division 1 requirements.
- B. Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, fittings, valves, hangers and supports. Include the designation of the publication applicable for each type of material and method.
  - 1. Grooved joint couplings and fitting shall be referred to on drawings and product submittals, and be identified by the manufacturer's listed model or series designation.
- C. Submit a letter from the refrigeration equipment manufacturer stating that the refrigeration



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pipng system, as shown on the contract documents, is acceptable for the equipment the manufacturer proposes to furnish, or submit drawings prepared by an authorized representative of the refrigeration equipment manufacturer.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Chilled Water (CHS/CHR) Piping (Grooved-end pipe not acceptable in VCSB)  
System Design Pressure: To 150 psig.
1. Piping, 1/4" thru 2": Contractor's option:
    - a. Type L Hard-drawn Copper Tubing: ASTM B88.
    - b. Schedule 40 carbon steel, seamless; ASTM A-106, Grade B, Type S.
    - c. Schedule 10S stainless steel, ASTM A-312, Type 304/304L.
  2. Piping, 2-1/2" thru 10": Schedule 40 carbon steel, seamless or electric resistance welded, ASTM A-53, Grade B, Type S or ERW.
  3. Piping, 12" through 24": Standard Wt., carbon steel, electric resistance welded, ASTM A-53, Grade B, Type ERW.
  4. Piping, 30" and larger: Standard Wt., carbon steel, double submerged arc welded, API - 5L, Grade B, Type DSAW.
  5. Pipe Fittings: 1/2" thru 2": Contractor's option:
    - a. Wrought Copper, ANSI B16.22.
    - b. 150lb. malleable iron threaded; ASTM A-197.
    - c. Mechanically formed tee fitting, as created by T-Drill, is an acceptable method of installation.
    - d. Stainless steel fittings shall be precision, cold drawn, stainless steel with elastomer O-ring seals, suitable for working pressure to 500-psig (3450-kPa). Victaulic Vic-Press.
  6. Pipe fittings 2-1/2" and larger: Schedule to match mating pipe, carbon steel, butt weld type, ASTM A-234. Weld-o-lets and thread-o-lets will be limited to 2 pipe sizes smaller than the pipe to which they are connected.
  7. Brazing: Contractors Option:
    - a. 5% silver, 6% phosphorus, balance copper, 1190°F melting point. AWS A5.8 number BCuP -3. J.W. Harris Stay-Silv® 5 or equal.
    - b. 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or equal.
    - c. 6% silver, 6.1% phosphorus, balance copper, 1190°F melting point. QQ-B-654A number BCuP -5. J.W. Harris Dynaflo® 5 or equal
  8. Unions: 1/2" thru 2": Contractor's option:
    - a. Wrought Copper, Pressure Class 150, w/solder ends.
    - b. Malleable Iron, Pressure Class 150, w/ threaded ends, ANSI B 13.39.
    - c. Note: Dielectric unions shall be used to connect copper to steel pipe, and shall have metal connections on each end threaded to match the adjacent piping. Metal components shall be separated by a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the system operating pressures and temperatures.

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9. Flanges: 150 lb. rated forged carbon steel; weld neck type, with raised face, bored to match the mating pipe I.D.; ASTM A-181, Grade 2, or ASTM A-105, Grade 2.
  10. Bolting studs: ASTM A-193, Grade B7. Nuts shall be heavy duty hex type; ASTM A-194, Grade 2H.
  11. Gaskets: Full faced style, 1/8"thick. Gasket material shall be Nitrile (NBR) sheet, ASTM F104, Line Call Out F712100A9B4E22K5M6; Based on Garlock Blue-Gard® Style 3000 or acceptable equivalent.
  12. Direct buried pipe shall be coated with an extrusion-applied, fusion bonded epoxy-coating jacket, 0.040" minimum thickness. Equal to 3M-SkotchKote™.
- B. A/C Unit Condensate Drain (D) Piping.  
System Design Pressure: 10 psig.
1. Drains, Indoor, not in Return Air Plenums - PVC:
    - a. Schedule 40 Polyvinyl Chloride (PVC), ASTM D1785.
    - b. Schedule 40 PVC, socket-type, ASTM D2466. Joints shall be made with solvent cement, ASTM D2564.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
  2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
  3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
  4. Not all necessary pipe offsets are indicated on the drawings because of the small scale. The various runs of piping to be installed shall be studied and adjustments made in exact routings as may be required for proper installation.
  5. Conflicts arising during the erection of piping shall be brought to the attention of the Owner's Representative. No improvising or field changes will be permitted without the approval of the Owner's Representative.
  6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
  7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
  8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Owner's Representative.

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9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.
10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipelines shall be grouped in the same horizontal or vertical plane.
11. Where lines are purposely pitched for drainage, an accurate grade shall be maintained. No lines shall be supported in such a manner as to permit deflection, due to gravity, sufficient to pocket the lines when full of liquid. Grade mains as indicated by arrows on the drawings and in accordance with gradient as
12. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Owner's Representative. Expansion bolts shall be used only upon the approval of the Owner's Representative.
13. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of valves and other items requiring maintenance.
14. Avoid bushings. Reducing fittings shall be used wherever practical.
15. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
16. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Owner's Representative before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.
17. Copper tubing and galvanized steel shall not be mixed in any one run of piping.
18. Change in direction shall be made with fittings, except that bending of steel and copper pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.
19. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping systems. When pipe joint is made up a maximum of 3 threads shall be visible.
20. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
21. Connections between ferrous and nonferrous metallic pipe shall be made with

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- dielectric unions or flanges.
- 22. Connections between plastic and metallic pipe, between plastic and glass pipe, and between metallic and glass pipe, shall be made with transition fittings manufactured for the specific purpose.
- 23. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Hydronic HVAC Systems Additional Requirements:

- 1. Provide water seal in the condensate drain from each air handling or air conditioning unit. The depth of each seal shall be equal to the total static pressure rating of the unit to which the seal is connected. Water seals shall be constructed of two tees and an appropriate U bends with the open end of each tee plugged.
- 2. Slope piping 1 inch per 40 ft, in the direction of flow.

3.2 BRAZING AND SOLDERING

A. Operator and Procedure Qualifications: All welding brazing operators and all brazing procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing:

- 1. Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering:

- 1. Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self-cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

- A. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.
- B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.
- C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

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- D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.
- E. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.
- F. Disconnect pressure boosting apparatus, and vacuum pumps, during the test time span specified for systems employing the pressure loss/time span test method.
- G. During tests, isolate system components that have test pressures less than pressures specified for system tests.
- H. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

END OF SECTION 15060

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SECTION 15071

PREINSULATED UNDERGROUND PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Preinsulated Underground Piping System.

1.3 QUALITY ASSURANCE

- A. The Division 15 sub-contractor shall provide a complete survey of the route of the piping systems including location of all existing utilities and topography to the supplier of the piping systems.
- B. The supplier of the piping systems shall be responsible for the design of the complete engineered preinsulated piping system, including carrier pipe, thermal insulation, protective jacketing, fittings, anchors, guides, expansion loops or joints and anchor block design.
- C. The supplier of the piping systems shall provide the installing contractor with complete installation drawings and specifications for trench preparation, concrete anchor or thrust block specifications. All units shall be part numbered to correspond to the installation drawings.
- D. All components of the piping system shall be suitably inspected after fabrication by X-ray or other means to ensure continuous insulation through each section.
- E. Manufacturer shall provide a qualified technician who will be present during critical periods of the installation and testing of the system.
- F. After installation and prior to backfilling, the manufacturer's representative of all piping components provided in this section shall field inspect the piping system and certify in writing to the Owner's representative that the piping system has been assembled and installed within the guide lines of the manufacturer's written installation instructions. This certification shall include but not be limited to trench preparation, anchor, guide and thrust block construction and location, backfill material, expansion loop and joint construction.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Division 1 requirements.
- B. Submit details of joint construction, expansion loop sizing, anchor, guide and thrust block construction.
- C. Submit pipe installation inspection report as described in 1.3.F.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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A. Preinsulated Underground Piping System:

1. Energy Task Force.
2. Insul-Pipe Systems
3. Ric-Wil/Perma Pipe.
4. Thermacor Process, Inc.
5. Thermal Pipe Systems, Inc.

2.2 FABRICATION

A. Preinsulated Underground Piping System:

1. Temperature range 20°F to 60°F; pressure 125 PSIG:
  - a. Carrier Pipe:
    - 1) Piping, 1/4" thru 2": Schedule 40 carbon steel, seamless; ASTM A-106, Grade B, Type S.
    - 2) Piping, 2-1/2" thru 10": Schedule 40 carbon steel, seamless or electric resistance welded; ASTM A-53, Grade B, Type S or ERW.
    - 3) Piping, 12" and larger: Standard Wt., carbon steel, electric resistance welded; ASTM A-53, Grade B, Type ERW.
    - 4) Where possible, provide in nominal 40 ft. lengths. Allow 6" of exposed pipe to permit field joining. Size as shown on drawings.
  - b. Fittings: Schedule to match mating pipe, carbon steel, butt weld type; ASTM A-234. Manufacturer to provide fitting insulation kits consisting of a hard shell mitered jacket equal to the carrier pipe jacket with field applied urethane insulation and heat shrink wrap by Canusa or Raychem. The use of interior PVC "zeston" style covers is not acceptable. The use of pressure sensitive tape to seal joints is not acceptable.
  - c. Insulation: 2 lb density polyurethane foam or 2 lb density preformed urethane 90-95% closed cell, 2" nominal thickness, "K" factor of .14 (Btuh sq.ft/deg.F/in) at 75°F.
  - d. Jacket: 20 Mil filament - wound polyester resin/fiberglass applied directly to insulation or Type 1, Grade 1 PVC piping with a minimum wall thickness of .060 inches, with liquid foam filled and formed between carrier pipe and outer conduit. Jacket suitable for 250 F continuous operation.
  - e. Provide all necessary expansion loops, anchors, guides, wall sleeve, mechanical rubber wall seal and all necessary accessories for field assembly and insulation of field joints.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install in accordance with manufacturer's written installation instructions, including but not limited to unloading and storing, drying of conduit and insulation in the event it becomes wet, trenching with proper attention to required cover height, providing concrete anchor blocks and installing anchor plates, laying, welding, cold spring procedure, field joint insulation procedure, conduit air test procedure and field joint coating procedure.

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- B. Prior to insulating and sealing joints and sealing fittings the system should be visually and hydrostatically tested as specified in Section 15060 - Pipe and Pipe Fittings.
- C. Underground systems shall be buried in a trench of not less than 24 inches deeper than the top of the pipe jacket and not less than 18 inches wider than the combined O.D. of all piping systems. Backfill should be tamped compactly in place. No rock shall be used in the first foot of the backfill. To meet H-20 highway loading, there must be 24 inches from top of jacket to grade of the compacted fill.
- D. Comply with inspection and certification requirements specified in Para. 1.3 - Quality Assurance.

END OF SECTION 15071



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SECTION 15080 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Automatic Flow Control Valves.
- B. Strainers.
- C. Thermometers and Accessories.
- D. Pressure Gauges and Accessories.
- E. Pressure and Temperature Test Ports.
- F. Install Miscellaneous Control Devices.

1.3 SUBMITTALS

- A. Submit schedule of all products used. Include make, model and size. When multiple products will be used, generic size and flow range will be acceptable.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Automatic Flow Control Valves: (NO SUBSTITUTIONS)
  - 1. Flow Design, Inc.
  - 2. Nexus Controls
  - 3. Griswold
  - 4. Tour & Andersson
- B. Strainers:
  - 1. American Wheatley
  - 2. Crane
  - 3. ITT Grinnell
  - 4. O.C. Keckley
  - 5. Mueller Steam Specialty Co. (MUESSCO).
  - 6. RP&C Division, Conbraco Industries, Inc.
  - 7. Victaulic Co. of America
- C. Thermometers and Accessories:

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1. Duro Instrument Corp.
2. Taylor
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter's ThermoGauges

D. Pressure Gauges and Accessories:

1. Ashcroft
2. Duro Instrument Corp.
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter's Thermogauges

E. Pressure and Temperature Test Ports:

1. Peterson Equipment Co., Inc.
2. Sisco P/T Plugs
3. Owner Approved Equal.

2.2 FABRICATION

A. Automatic Flow Control Valves:

1. HVAC or Potable Water Service:

- a. Size ½" thru 2-1/2": Brass wye body design, thread or sweat connection, ground joint union, dual temperature and pressure test ports extended to clear required insulation, range 20°F to 230°F rated at 400 psi water. Stainless steel or nickel plated piston brass orifice and spring, replaceable without removing from installation, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Flow Design, Inc. AutoFlow Model YR or approved equal.
- b. Size 2-1/2" thru 12": Ductile iron body, wafer style connection, dual temperature and pressure test ports, range 20°F to 230°F rated at 150 psi. Stainless steel or nickel plated piston brass orifice and spring, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Flow Design, Inc. AutoFlow Model WS or approved equal.

B. Combination Automatic Flow Control and Shutoff Valves:

1. HVAC or Potable Water Service:

- a. Size ½" thru 2: Brass wye body thread or sweat connection, union, two-temperature and pressure test port extended to clear require

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insulation, brass or bronze ball valve with stainless steel ball and stem, non-thermal conductive material type actuator extended to clear required insulation for chilled water applications, steel lever type for heating applications. Range 20°F to 230°F rating 400 psi water. Stainless steel or nickel plated piston brass orifice and spring, replaceable without removing from installation, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Flow Design, Inc. AutoFlow Model AC or approved equal.

B. Strainers:

1. "Y" Pattern:

a. HVAC Water Service:

- (1) Size 1/4" thru 2": Cast iron body, threaded connection, threaded blow-off cover, removable stainless steel screen .045" perforations, rated at 450 PSIG. Based on Mueller Steam Specialty Co. (MUESSCO) #11M or approved equal.
- (2) Size 2-1/2" and up: Cast iron body, flanged connection, flanged blow-off cover. Blow-off cover tapped for blow-off valve, removable stainless steel screen .045" perforations, rated at 125 PSIGG. If grooved mechanical system is in use a "T" type grooved end, ductile iron body, available with blow off, 304 SS removable screen, choice of mesh size. Based on Victaulic Style 730 (grooved T type) Mueller Steam Specialty Co. (MUESSCO) #751 or approved equal.

C. Thermometers and Accessories:

1. Industrial Reading Non-Mercury Type:

- a. Construction: Adjust angle, 9" scale with lagging extension brass well, of the blue or red reading spirit (organic) fill type and guaranteed accurate to  $\pm$  one scale division. Thermometer shall have glass front to exclude dirt and dust. Thermometers containing mercury are not acceptable. Thermometers installed outdoors shall be specifically designed and weatherproofed for this application.
- b. Stem Length:
  - (1) 6" pipe and smaller 3-1/2"
  - (2) 8" to 12" pipe 6"
  - (3) For storage tanks 9"
- c. Ranges:
  - (1) Chilled and condenser water 0 to 120°F or 0 to 100°F as available.
  - (2) Domestic & heating hot water 30 to 240°F
- d. Based on Weksler Type EG5H-9 or approved equal.

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2. Bi-Metal Dial Type:
  - a. Construction: 5" dial, adjust-angle, with lagging brass extension well. Stainless steel case bezel, fittings and stem. Head assembly sealed against dust, fumes and moisture with glass window. Accuracy of  $\pm 1\%$  of thermometer range and also be externally adjustable.
  - b. Stem Length:

(1)	6" pipe and under	2-1/2"
(2)	8" to 12" pipe	4-1/2"
(3)	For storage tanks	7-1/2"
  - c. Range:

(1)	Chilled and condenser water	0 to 150°F
(2)	Domestic & heating hot water	20 to 240°F
  - d. Based on Weksler Type AF or approved equal.
3. Thermometer Well: Construction - Brass or ductile iron body, with lagging extension, length to accommodate thermometer stem length. Based on Weksler or approved equal.

D. Pressure Gauges and Accessories:

1. Pressure Gauges:
  - a. Construction: 4-1/2" dial, high impact polypropylene case, 1/4" bottom connection, 1/2% accuracy in accordance with ANSI B40.1 - 1974 Grade A. Stainless steel rotary with stainless steel pinion gear; stainless steel sector gear; stainless steel link. Stainless steel bourdon tube, 316 stainless steel socket and slotted adjustable pointer.
  - b. Case of black high impact polypropylene suitable for surface or direct mounting and with bottom connection. For outdoor locations, provide glycerine filled gauges.
  - c. Range: Ranges shall be so selected to indicate pressure reading in midpoint of scale selected.
  - d. For condenser water, ice water and other open system pumps, provide a compound gauge with dial calibrated to read in. hg. vac. as well as pressure.
  - e. Based on Weksler Model AA44-2 and AY44-2 or approved equal.
2. Ball Valve Shut-Off: See Ball Valves Section 15100.
3. Manifold Valves (Trumpet Valve) (Water):
  - a. 2, 3 or 4 port. Brass body, spring return, push button brass valves, 1/4" compression connections. Gauge tap at top, calibrated gauge test port with gauge cock. 125 PSIG rated, 20°F to 220°F range. Based on Flow Conditioning Corporation Hydronic Indicator System or approved equal.
4. Piston type snubber: Brass body, threaded connections, suitable for mounting horizontal or vertical. (Required at pump inlet and discharge.) Based on Weksler Type RS-1 or approved equal.
5. Filter type snubber: Brass body, threaded connection, micro metallic stainless steel filter. (For all gauges except pump service). Based on Weksler Type

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BW42 or approved equal.

- E. Pressure and Temperature Test Ports:
1. Brass or stainless steel body with threaded cap and gasket, length to extend past insulation.
  2. Two self closing valves with intermediate pocket for added pressure protection. Sized for standard 1/8" probe.
  3. Range: 20°F to 230°F.
  4. Rating: 250 PSIG water.
  5. Based on Peterson Equipment Co., Inc. "Pete's Plug" Model 110 or 110XL or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturers written installation instructions.

3.2 INSTALLATION

A. Flow Control Valves:

1. Install with taps in upright or vertical position.
2. Tag valve for:
  - a. Type of service.
  - b. Flow in GPM.
3. The contractor shall assume the responsibility to obtain the necessary gauges and thermometers to properly take the differential pressure and temperature readings from the flow control valves.
4. All flows shall be verified.

B. Strainers:

1. "Y" Patterns:
  - a. Strainers preceding automatic steam control valves shall be installed with the strainer branch in the horizontal position to eliminate the formation of a water pocket in the strainer branch.
  - b. All non-steam "Y" pattern strainers shall be installed with the strainer branch in the downward vertical position.
  - c. For all "Y" pattern strainers, provide blow-off valve assembly consisting of ball-type drain valve with hose end cap and pipe nipple.
2. Basket Strainer:
  - a. Install basket strainer on housekeeping pad with rubber mat between pad and strainer (See Section 15210: Vibration Isolation for specs on rubber mat).
  - b. Provide manual air vent in top of cover.
  - c. Provide ball valve nipple and plug for drain valve assembly. Valve to be 3/4" unless otherwise noted.

C. Thermometers and Accessories:

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1. Install and adjust thermometers for optimum visibility.
2. Provide thermometers where indicated on schematic flow diagram or schematic equipment details.
3. Install thermometers in compatible thermometer wells.

D. Pressure Gauges and Accessories:

1. Install and adjust gauge for optimum visibility.
2. Provide ball valve shut-off for all hydronic gauges.
3. Provide needle valve for all steam gauges.
4. Provide siphon for all steam gauges.
5. Provide a manifold valve to facilitate the use of a single gauge to monitor pressure differential from various points of a single piece of equipment (i.e. pump; strainer suction; pump suction; pump discharge, etc.). Mount valve for optimum visibility and access.
6. In lieu of the trumpet valve the contractor may assemble individual components using ball valves as the isolation valve provided the same functions of the trumpet valve are duplicated.
7. Provide piston type snubbers for pump service.
8. Provide filter type snubbers for all other fluid services.
9. Open shut-off valve only enough to obtain accurate reading. Valve to gauge to be closed at all other times.

E. Pressure and Temperature Test Ports:

1. Install in upright or vertical position as indicated on schematic flow diagram or schematic equipment details.
2. Install in tee or welded outlet.

F. Install miscellaneous control devices such as thermometer wells, tees for flow measuring stations, connections for differential pressure sensors, etc.

END OF SECTION 15080

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SECTION 15090  
SUPPORTS, HANGERS, ANCHORS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Inserts, Shells and Upper Attachments.
- B. Pipe Hangers, Rods, Supports and Accessories.
- C. Pipe Sleeves.
- D. Pipe Seals.
- E. Duct Hangers and Supports.

1.3 QUALITY ASSURANCE

- A. Design of pipe supporting elements shall be in accordance with ANSI B31.1.
- B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards.
  - 1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
  - 2. SP-69 Pipe Hangers and Supports: Selection and Application.
  - 3. SP-89 Pipe Hangers and Supports: Fabrication and Installation Practices.
- C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications, and hot galvanized for exterior applications.
- D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.
- E. Welding of steel members shall be in accordance with AWS D1.1.
- F. Duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible as applicable.

1.4 APPLICABLE PUBLICATIONS

- A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced to in the text by the basic designation only.
  - 1. American Institute of Steel Construction (AISC)
  - 2. American National Standards Institute (ANSI)
  - 3. American Society for Testing and Materials (ASTM)
  - 4. American Welding Society (AWS)
  - 5. The Manufacturer's Standardization Society of the Valve and Fittings Industry

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- (MSS)  
6. Sheet Metal and Air Conditioning Contractor's National Association, Inc.  
(SMACNA)

1.5 SUBMITTALS

- A. Submit in accordance with Division 1 requirements.
- B. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.
- C. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Inserts, Shells and Upper Attachments:
1. Anvil International, Inc.
  2. Carpenter Paterson, Inc.
  3. Cooper B-Line®, Inc.
  4. Elcen Metal Products
  5. Hilti
  6. Michigan Hanger Company
  7. PHD Manufacturing, Inc.
  8. Unistrut®
- B. Pipe Hangers, Rods, Supports and Accessories:
1. Anvil International, Inc.
  2. Carpenter Paterson, Inc.
  3. Cooper B-Line®, Inc.
  4. Elcen Metal Products
  5. Hilti
  6. Michigan Hanger Company
  7. PHD Manufacturing, Inc.
  8. Unistrut®
- C. Pipe Sleeves:
1. Metraflex – Metraseal
  2. Thunderline Corporation - Link Seal
  3. Owner Approved Equal.
- D. Pipe Seals:
1. Metraflex – Metraseal
  2. Thunderline Corporation - Link Seal
  3. Owner Approved Equal.
- E. Duct Hangers and Supports: Fabricated per Specifications

2.2 FABRICATION



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A. Inserts, Shells and Upper Attachments:

1. Inserts; MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable. Rated for 1,140 lbs. Based on Anvil Fig. 282 or approved equal.
2. Shells: Steel shell and expander plug, snap off end fastener. Based on Phillips Concrete Fasteners Red Head or approved equal.
3. Upper Attachments:
  - a. Top beam clamps; MSS Type 19: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut. Rating is contingent on rod and bolt size. Based on Anvil Fig. 94 or approved equal.
  - b. Bottom Beam Clamp; MSS Type 23: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut, and retaining clip. Rating is contingent on rod and bolt size. Based on Anvil Fig. 86 Clamp and Fig. 89 Retaining Clip (or Fig. 87) or approved equal.
  - c. Welded Beam Attachment; MSS Type 22: Carbon steel suitable for eye rod or rod and locknut, rating is contingent on rod and bolt size. Based on Anvil Fig. 66 or approved equal.
  - d. Center Beam Clamp; MSS Type 21: Malleable iron jaw and square head bolt and nut with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 134 or approved equal.
  - e. Center Beam clamp; MSS Type 29: Forged steel, weldless eye nut, tie rod to secure clamp to beam all with galvanized finish, rating is contingent on rod and bolt size. Based on Anvil Fig. 292 or 292L or approved equal.

B. Pipe Hangers, Rods, Supports and Accessories:

1. Pipe Hangers:
  - a. Clevis Hanger; MSS Type 1: Carbon steel, galvanized for interior and exterior use, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 260 or 300 or approved equal.
  - b. Pipe Rings; MSS Type 10: Carbon steel, galvanized for black steel and insulated pipe copper or copper plated or rubber coated for copper pipe. Threaded swivel, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 69 or Fig. 97C for copper pipe or approved equal.
  - c. Adjustable Roller Hanger; MSS Type 43: Cast iron roll, carbon steel yoke rod roll and hex nut with galvanized finish. Sized to accommodate insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 181 or approved equal.
2. Rods:
  - a. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

<u>Pipe Size</u>	<u>Pipe Size</u>	<u>Rod Size</u>	<u>Max Equip. Load</u>
Copper Tube, Plastic Fiberglass Reinforced	Steel, Cast Iron or Glass		
1/4" to 2"	1/4" to 2"	3/8"	730 lbs.
2-1/2" to 5"	2-1/2" to 3"	1/2"	1350 lbs.

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6"	4" to 5"	5/8"	2160 lbs
8" to 12"	6"	3/4"	3230 lbs.
14"	8" to 12"	7/8"	4480 lbs.
16"	14" to 16"	1"	5900 lbs.
18" to 20"	18" to 20"	1-1/4"	9500 lbs.
22" to 42"	22" to 42"	1-1/2"	13,800 lbs.

- b. Rods may be reduced one size for double rod hangers with 3/8" minimum diameter, or when other paragraphs require a minimum of 2 hangers per section provided the minimum diameter of 3/8" is maintained. Based on Anvil Fig. 146 or approved equal.

3. Supports:

- a. Pipe Saddle; MSS Type 38: Cast iron saddle, black steel lock nut nipple, cast iron reducer all with galvanized finish. Suitable for standard field cut and threaded galvanized steel pipe. Cast iron floor flange. Based on Anvil Fig. 264 Saddle, Fig. 63 Floor Flange or approved equal.
- b. Pipe Saddle Cold Piping; MSS Type 40. Single bonded unit consisting of a galvanized metal shield and a molded section of rigid polyurethane foam insulation. Rigid urethane foam shall have a density of 4 pounds per cubic foot, a thermal conductivity of 0.13 Btu.in/sq.ft./hr.°F at 75°F mean temperature. Insulation thickness to be equal to thickness specified for pipe being supported.
- c. Adjustable Pipe Roll and Base; MSS Type 46: Cast iron base plate steel stand and roll, adjusting screws with galvanized finish. Based on Anvil Fig. 274 or approved equal.
- d. Welded Steel Bracket; MSS Type 32: Welded carbon steel rate for 1500 lbs., with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 195 or approved equal.
- e. Riser Clamps; MSS Type 8: Carbon steel, galvanized finish for black steel or galvanized pipe, plastic coated for cold steel, copper, glass or brass pipe rated for a minimum of 220 lbs. at 3/4" size. Based on Anvil Fig. 261 or approved equal.

4. Accessories:

- a. Protective Shields; MSS Type 40: Carbon steel, galvanized minimum of 12" length sized for required insulation. Based on Anvil Fig. 167 or approved equal.
- b. Protective Saddles; MSS Type 39: Carbon steel plate, minimum of 12" length, sized for required insulation. Based on Anvil Fig. 160 thru 165 or approved equal.
- c. Steel Turnbuckle; MSS Type 13: Forged steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 230 or approved equal.
- d. Steel Clevis; MSS Type 14: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 299 or approved equal.
- e. Weldless Eye Nut; MSS Type 17: Forged steel, galvanized finish. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 290 or 290L or approved equal.

C. Pipe Sleeves:

1. Wall: Schedule 40 carbon steel pipe sized to accommodate pipe, insulation and

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- firestopping. See Division 7 for firestopping. If sleeves are field cut coat cut edges with cold galvanizing spray, ZRC or equivalent.
2. Floor or Exterior Walls below Grade: Schedule 40 steel pipe with anchor and water stop hot dip galvanized after fabrication. Sized to accommodate pipe and waterproofing or firestopping. Refer to Division 7 for firestopping requirements. Sleeve length will be sized to allow a minimum of 1/2" extension below floor or exterior side of a wall below grade and 1-1/2" extension above floor and 1/2" extension on interior side of an exterior wall below grade.
  3. Roof: All penetrations of roof to be in accordance with requirements of Division 7 - Thermal and Moisture Protection.
  4. Based on Thunderline Corp. Link Seal Wall Sleeve or approved equal.
- D. Pipe Seals: Composition Plastic Pressure Plates, zinc coated bolts, nuts and metal parts, composition rubber sealing element designed for long term stability rated for temperatures of 40°F to +250°F. Based on Thunderline Corp. Link Seal LS Series or approved equal.
- E. Duct Hangers and Supports: Fabrication and application of duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, Latest Edition, as applicable.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Where applicable install in accordance with the manufacturers written installation instructions.
- B. Where supports are in contact with copper pipe provide copper plated support, or wrap pipe with sheet lead.
- C. Where supports are in contact with glass, aluminum or brass pipe provide plastic coating on supports, or wrap pipe with sheet plastic.
- D. General interior supports, including attachments and pipe supports that are plain steel shall be cleaned of all rust, primed and painted black within one week of installation. At substantial completion all supports shall be free of rust and in a "like new condition".
- E. Hangers and supports, including attachments & pipe supports, exposed to weather or located in utility tunnels or accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication. At substantial completion all supports shall be free of rust and in a "like new condition".

3.2 INSTALLATION

- A. Inserts, Shells and Upper Attachments:
  1. Inserts:
    - a. Contractor shall have inserts at site and dimensioned location drawings ready at the beginning of the involved concrete work.
    - b. Install inserts by securing to concrete forms and inserting reinforcing rod thru the opening provided in the insert in accordance with shop drawings.
    - c. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

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2. Shells: Size shell length to assure a minimum of 1" solid concrete remaining from shell end to concrete face.
3. Upper Attachment:
  - a. Select proper attachment for building construction.
  - b. For plain steel devices, prime with black paint prior to installation.
  - c. Adjust attachment location for proper alignment and no more than 4 deg. offset from a perpendicular alignment.
  - d. If proper alignment cannot be achieved from the existing building structure provide a trapeze type support size to handle the design load with a minimum safety factor of 5.

B. Pipe Hanger, Rods, Supports and Accessories:

1. Select proper hanger for piping systems.
2. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.
3. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.
4. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.
5. Hangers shall be fabricated to permit adequate adjustment after erection while still supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.
6. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.
7. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.
8. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturers written installation instructions, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT  
 SPACING TABLE

a.	Steel Pipe (Schedule 40 & 80):	
	Up to 1":	7 ft. on center
	1-1/4" and larger:	10 ft. on center
b.	Copper Pipe (Types L, K and M):	
	Up to 1" size:	5 ft. on center
	1-1/4" and larger:	7 ft. on center
c.	Ductile Iron and Cast Iron: Two hangers per section length.	
d.	Polyvinyl Chloride (PVC):	
	Up to 1-1/2":	3 ft. on center

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2" and larger:

4 ft. on center

9. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.
10. Parallel piping may be supported by trapeze hangers consisting of steel angle, channel, or beam suspended by steel rods attached to upper structure. Piping may be supported above, or suspended below, the angle, channel, or beam.
11. Provide protective shields on all cold and dual temperature piping required to be insulated.
12. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.
13. Provide turnbuckles on all hangers which require leveling or aligning.
14. Provide steel clevis where detailed and/or required.
15. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.

C. Pipe Sleeves:

1. Secure sleeves to forms for concrete construction. Ensure sleeves are not disengaged or misaligned by concrete placement operations.
2. Provide temporary cap for open end of sleeves to prevent entrance of concrete.
3. Provide temporary internal bracing where required to prevent distortion of sheet metal sleeves by concrete placement operations.
4. Sleeves shall not be installed in structural members, except where indicated or approved.
5. Furnish sleeves to masonry contractor in advance of masonry work. Furnish dimensioned drawings indicating exact location of sleeves.
6. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface, except as indicated otherwise.
7. Sleeves passing through floors in wet areas, such as areas containing plumbing fixtures or floor drains, shall extend a minimum of 4 inches above the finished floor. Sleeves in wet areas shall be enclosed with 4 inch concrete curb.
8. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance all around between the pipe and inside of sleeve, or between jacket over insulation and sleeve.
9. Provide membrane clamping devices on sleeves for waterproof floors.
10. Sleeves are not required in existing structures where openings through existing concrete floors, walls, or roof are core drilled.

D. Pipe Seals:

1. Provide pipe seals for all pipe sleeves used in:
  - a. External walls.
  - b. Floor slabs on grade.
  - c. Upper floors where spillage may occur.

E. Duct Hanger and Supports: Installation of duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, Latest Edition, as applicable.

END OF SECTION 15090

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SECTION 15100  
VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Ball valves.
- B. Butterfly valves.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referenced to in the text by the basic designation only.
  - 1. American National Standards Institute (ANSI).
  - 2. American Society for Testing and Materials (ASTM).

1.4 SUBMITTALS

- A. Submit schedule and cut-sheets indicating service, make and model number, pressure class, end type and usage (i.e., balance, shut-off).
- B. Product data shall be included in the operation for maintenance instruction manuals along with installation, operation and maintenance instructions.
- C. Refer to Division 1 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Ball Valves:
  - 1. Apollo
  - 2. Crane Company
  - 3. Milwaukee Valve.
  - 4. Nibco, Inc.
  - 5. Stockham
  - 6. Victaulic Co. of America.
  - 7. Watts
- B. Butterfly Valves:
  - 1. API International, Inc.
  - 2. Bray International, Inc.
  - 3. Crane Company
  - 4. Milwaukee Valve
  - 5. Nibco, Inc.
  - 6. Stockham

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7. Victaulic Co. of America.

2.2 FABRICATION

A. Ball Valves:

1. HVAC water service:

- a. Size 1/4" thru 2". Two piece, adapter loaded, full port type with brass body, threaded or sweat connection, stainless steel stem, stainless steel ball, teflon or silicone bronze seat, steel lever handle, indicator stop, 150 lb. 600 WOG.
- b. Size 1/2" thru 2". Two piece, standard port type with brass body, Vic Press 304™ connection, brass ball and stem, Teflon seat, carbon steel handle, 300 CWP. Victaulic Series 589 or approved equal.
- c. Valves installed in insulated piping to have extended handles to clear insulation. Stem extension shall be made of a non-thermal conducting material with a sleeve to form an insulated vapor seal after the valve is insulated. Based on Nibco T-585-70-66 or approved equal.

B. Butterfly Valves:

1. HVAC water service – Above Ground Use:

- a. Size 2-1/2" thru 4": 416 stainless steel stem, lug wafer body drilled and tapped for isolation and removal of downstream piping, cast iron or ductile iron body, long neck body extended to allow for a minimum of 2" insulation, aluminum bronze or stainless steel disc, bubble tight EPDM seat, infinite position, memory stop handle. Class 150, 20°F to 210°F range. Based on Nibco LD-2000-3 or approved equal.
- b. Size 2-1/2" - 12" grooved end: Ductile iron body to ASTM A-536 with electroless nickel plated ductile iron disc to ASTM A-536, offset stainless steel stem, full 360° seating. EPDM pressure responsive seat. 2-1/2" - 4" to have infinitely variable memory stop handle. Valves 6" and above to have gear operator. Valve has bubble tight shut off up to 300 psi and 230°. Valve will have extended neck .. allowing up to 2" insulation. Based on Victaulic Vic®-300 MasterSeal™ or approved equal...
- c. Valves installed in insulated piping to have extended handles to clear insulation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide shut-off valves on the inlet and outlet of each piece of equipment at the take-off of each major branch from a header and at the base of each pipe riser in order to facilitate service.
- B. Provide drain valves at the base of each pipe riser and at each piece of equipment to facilitate service.
- C. Provide locking device on handle of the expansion tank isolation valve to prevent accidental closing.

3.2 INSTALLATION

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A. Ball Valves:

1. Install valves with adequate access to lever actuator.
2. Provide adequate space for actuator handle in the open and closed position and for packing replacement.
3. Provide infinite position handle with memory stop on the outlet of all heat exchangers for balancing purposes.

B. Butterfly Valves:

1. Install valve between face of 125# or 150 standard ANSI flanges or standard grooved couplings.
2. Assure unrestricted valve movement after installation. Valves should be installed with stem of valve parallel to floor.

END OF SECTION 15100



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SECTION 15170  
AIR CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Pressurized Expansion Tank
- B. Air Separator
- C. Automatic Air Vent
- D. Chilled Water Buffer Tank

1.3 QUALITY ASSURANCE

- A. Expansion tanks shall be constructed with materials and standards which comply with the following standards:
  - 1. American Society of Mechanical Engineers (ASME) Codes:
  - 2. Boiler and Pressure Vessel Code: Section VIII Pressure Vessels, Division 1.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Division 1 requirements.
- B. Submit schedule indicating make, model, size, etc. by system.
- C. Submit statement of Code compliance where applicable.
- D. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURE

- A. Pressurized Expansion Tank:
  - 1. Amtrol, Inc.
  - 2. Armstrong Pump Company
  - 3. Bell & Gossett
  - 4. Taco, Inc.
  - 5. Wheatley Gaso, Inc.
  - 6. Wood Industries, Inc.
- B. Air Separator:
  - 1. Armstrong Pump Company.
  - 2. Bell & Gossett, Inc.
  - 3. Taco, Inc.

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4. Wheatley Gaso, Inc.
5. Wood Industries, Inc.

C. Automatic Air Vent:

1. Armstrong Pump Company
2. Bell & Gossett, Inc.
3. Taco, Inc.

D. Chilled Water Buffer Tank

1. Cemline
2. Hanson Tank
3. John Wood Company
4. Niles
5. Wessels Company

2.2 FABRICATION

A. Pressurized Expansion Tank:

1. Closed type, welded steel construction, ASME stamped and rated for 125 PSIG working pressure at 240°F, National Board Form U-1A attached.
2. Replaceable elastomeric bladder to separate water and air.
3. Tappings for system connection, remote air connection, charging valve enclosure, drain connection.
4. Bolted and gasketed handhole for bladder replacement, lifting ring top and side, integral steel base ring for vertical mounting.
5. Factory precharged with air to scheduled pressure.
6. Factory cleaned and coated outside with prime coat of rust inhibitive paint.
7. Based on Bell & Gossett Series B or approved equal.

B. Air Separator:

1. Tangential flow pattern, welded steel construction, ASME stamped and rated for 125 PSIG working pressure at 350°F, National Board Form U-1A attached.
2. Connections for system inlet and outlet, expansion tank, drain.
3. Perforated stainless steel air collector tube.
4. All acceptable manufactures to submit on an air separator without a strainer.
5. Based on Bell & Gossett Rolairtrol or approved equal.

C. Automatic Air Vent: Non-ferrous, automatic air vent rated for 240°F and 150 PSIG. Based on Bell and Gossett Model 87 or approved equal.

D. Chilled Water Buffer Tank:

1. Designed and built in accordance with the ASME BPV Code Section VIII, Division 1.
2. Shell: Carbon Steel with exterior gray primer finish.
3. Center baffle plate: Carbon Steel.
4. Inlet/outlet connections: FNPT, flanged, or grooved-end pipe.
5. Vent and drain connections: FNPT.
6. Standard angle legs provide 14" clearance from the bottom of the head to the floor.
7. 60 through 400 gallon tanks include one (1) 2" NPT inspection opening with plug.

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8. 528, 850, and 1040 gallon tanks include one (1) 4" x 6" handhole inspection opening.
9. Maximum design pressure: 125 PSI (862 kPa)
10. Maximum design temperature: 650°F (343°C)

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturers written instructions.
- B. Install air vents at all high points of system to facilitate air removal for proper flow and heat transfer.

3.2 INSTALLATION

- A. Pressurized Expansion Tank:
  1. Isolate tank from system during system flushing and cleaning operations.
  2. Vent excess air from tank prior to system heat-up.
  3. Ensure that tank is properly charged with air at start of warranty period.
  4. Install automatic air vent and pressure gauge at inlet.
  5. Provide equipment tag indicating required charging pressure.
  6. Provide drain valve and hose bibb adaptor.
- B. Air Separator:
  1. Support independently of connecting piping.
  2. Install tap size union and gate valve with locking hand wheel in line to expansion tank.
  3. Install full tap sized nipple, ball valve and plug for drain valve assembly.
- C. Automatic Air Vent:
  1. Install where shown on drawings or standard details.
  2. Install 1/2" ball valve and nipple between automatic air vent and system.
  3. Provide proper access.
  4. Do not install automatic air vent in concealed or non-accessible areas or where leakage may cause damage.
  5. Pipe discharge to nearest floor drain.
- D. Chilled Water Buffer Tank:
  1. Factory installed 1-1/2" flexible, elastomeric thermal insulation, with field installed aluminum jacket.
  2. Installation Arrangement: Vertical.
  3. Install all vent and drain connections.
  4. Ensure tank is level on housekeeping pad.
  5. Confirm connection sizes and any reducers or spool pieces required for connection to main piping system.

END OF SECTION 15170

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SECTION 15220  
WATER TREATMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Feeding and Control Equipment with all Piping and Wiring for each System.
- B. Closed Loop Temporary Filter.
- C. Pre-Operation Cleaning of each System.
- D. Initial Water Analysis and Recommendations.
- E. Water Treatment Chemicals for each System.
- F. Test Equipment.
- G. Training of Operating Personnel Including Written Instructions, Log Sheet and Record Forms.
- H. Follow-up service for one (1) full year from date of start-up including laboratory assistance.

1.3 SYSTEMS TO BE TREATED

- A. Chilled Water (CHS/CHR).

1.4 QUALITY ASSURANCE

- A. All electrical components shall be UL or ETL listed or labeled.
- B. All wiring shall conform to the NEC.
- C. The pre-cleaning and chemical charging shall be by or supervised by personnel trained in the field of water treatment. Chemicals shall be charged into the system within 24 hours of flushing and during circulation.
- D. All chemicals shall be compatible with system materials of construction and shall comply with all applicable EPA and regulatory agency standards.
- E. After charging of the system and for a period of one (1) full year after the date of start up the water treatment supplier shall periodically inspect the system and perform all necessary tests (minimum of 4) to properly evaluate the chemical concentration.
- F. After completion of the system the water treatment supplier shall train the owner in the proper maintenance procedures and future system requirements.
- G. After completion of the system water treatment, the contractor shall provide a water analysis and certify in writing to the Owners Representative that the system or systems

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have been properly flushed, cleaned and charged with the proper chemical concentration and that the Owner has been instructed in proper maintenance procedures.

- H. Corrosion coupon analysis by manufacturer's laboratory with test report at the end of the first year of operation.

1.5 SUBMITTALS

- A. Submit schedule indicating make, model and size by system.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 for requirements.
- D. Submit letter of certification as described in 1.4.G.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. American Water Chemicals, Inc.
- B. AquaTrol™ Division of Momar, Inc.
- C. Betz
- D. Chem Aqua.
- E. Chem-Treat, Inc.
- F. Nalco
- G. Southeast Water Labs

2.2 PIPING SYSTEMS AND WATER TREATMENT SYSTEMS

- A. Chilled Water (CHS/CHR) : Closed Loop

2.3 WATER TREATMENT REQUIREMENTS

- A. Closed Loop:
  - 1. General: Manual feeding of chemicals into filter style shot feeder and in turn into system in accordance with initial water evaluation and continuing test result requirements.
  - 2. Feeding and Control Equipment:
    - a. Five gallon combination filter-feeders, quantity as shown on drawings. Equal to Efficiency Dynamics, Ft. Worth, TX 76101, FF- 100, including steel shell with stainless steel basket, filter bag capable of 40 gpm flow with filter efficiency of 5 microns at 3 psi pressure drop and hand removable cap. Suitable for 150 psi and temperatures to 200°F.
    - b. Twelve (12) filter bags or provide only one (1), if filter is cleanable.
    - c. Corrosion coupon rack including corrosion probe connection fittings, one carbon steel and one copper corrosion coupon with holders and two (2)

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- corrosion coupon tees.
  - d. Totalizing make-up water meter equal to Master Meter Multi-Jet for installation in make-up water line. Meter to be sized per the plumbing drawings and shall have contacts for monitoring by the Building Control System.
  - e. Installation accessories including piping, fittings, shut off valves, drain valves, pressure gauges to measure pressure loss thru filter and automatic flow control valve set for 8 GPM as specified in Section 15080 Piping Specialties.
3. Closed Loop Temporary Filter:
- Provide an HPF-1665-1-CL ANCOPure™ HPF Closed Loop Filter or approved equal on the chilled water system. The filter must be installed and operational from the start-up of the chillers through substantial completion. The Owner shall be provided with a sample of the water each month from the contractor and the filter shall not be removed until the Owner and Engineer have signed off on the water quality.
- a. Provide 1-one 16"x65" Polyglass filter tank, rated for 100 PSI maximum design pressure
  - b. Piping shall be 1" with a 1" multiport control valve
  - c. 100 lbs. of gravel per tank
  - d. Filter Media: HPF
  - e. Filtered Particulate Size: 5 Microns
  - f. Quantity of Filter Media Per Tank: 4 FT<sup>3</sup>
  - g. Inlet/Outlet Gauge Set w/ Sample Valve: 0-160 PSI
  - h. Normal Service Flow Rate: 17 GPM
  - i. Peak Flow Rate: 14 GPM
  - j. Backwash Flow Rate: 100
4. Water Treatment Chemicals:
- a. All chemicals necessary for flushing and pre- cleaning.
  - b. All chemicals, in liquid form, necessary to control scale, corrosion, microbiological growth and water PH. Quantity to last one (1) full year from date of start up.
5. Side Stream Cartridge Filter System:
- a. Housing: A round multi-filter housing constructed of carbon steel with a 150 psi pressure rating at 300°F. The housing design shall include a large rounded bottom sump area so that the filter baskets may have a rounded bottom for particulate accumulation. The top portion of the fixed housing shall be equipped with a carbon steel plate with holes cut for the filter baskets. Filter basket holes shall be equipped with buna o-ring gaskets to prevent bypass around filter. Housing shall include a davit swing arm to remove the top for access to filter housings. Access to the housing shall be through the use of swing bolts with eye-nuts. Housing shall also include the following features: vent and drain port and gauge ports to measure differential pressure across the filter media. Piping connections shall be either ANSI 150# flanges or grooved for mechanical joint connection. The entire assembly shall be sand blasted and finished inside and out with a two part epoxy finish.
  - b. Filter Baskets: A 316 stainless steel basket with perforations. Basket shall be designed to accept standard liquid bags.

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- c. Liquid Filter Bags: Heavy duty filter media designed to filter at least 46 GPM of water per square foot of filter area with a maximum pressure loss of 8 psig at this valve. Filter media shall be suitable for intended fluid and shall have a filter rating of 5 microns absolute. Provide two complete spare sets of filters.
- d. Based on Krystil Klean Multi-Round Liquid Bag Housing or approved equal.

2.4 TEST EQUIPMENT

- A. Test equipment to properly evaluate the chemical levels within the system. The test equipment shall include but not be limited to: Carrying case or cabinet, all necessary reagents for determination of corrosion inhibitor level pH, P & M, alkalinity and chlorides as well as microbiological colony population and biocide effectiveness.

PART 3 - EXECUTION

3.1 GENERAL

- A. Each piping system is to be provided with the specified hardware. Where multiple evaporative condensers or closed circuit fluid coolers are specified, each is to be provided with its own chemical feed equipment.
- B. All products shall be installed or services performed in strict accordance with the manufactures written installation/procedure instructions.
- C. All piping systems and related equipment shall be thoroughly flushed with pre-cleaning detergent and dispersant designed to remove deposition from construction, such as pipe dope, oils, most loose mill scale, and other extraneous materials. The products used shall inhibit corrosion of the various metals in the system and shall be safe to handle and use. Effectiveness of the product shall be such that the water need only be at ambient temperatures. Add recommended dosages of chemicals and circulate for 48 hours. System shall then be drained from the lowest point in the system with make-up water fed to the system. During the draining process, the circulating pumps shall be in continuous operation to prevent settling, and circulation and draining shall continue until the total alkalinity and pH of the water is equal to the makeup water. Contractor is cautioned to be sure temperature and pressure in system during flushing does not cause rupture disc on chiller or relief valves etc. to blow.
- D. Install chemicals required for treatment of each system within 24 hours of completion of cleaning prior to start-up and operation of the system. Contractor shall measure water quantity required to fill system and provide this information to water treatment equipment supplier and tabulate this data in the operation and maintenance manuals.
- E. After cleaning and filling the mechanical system, operate the system for a period of one (1) year, one (1) visit per month during that time. Testing and sampling shall continue until the graph indicates the water treatment is maintaining the specified levels of 800 PPM to 1200 PPM of Nitrites and a maximum of 1 PPM of total iron levels of chemical within plus or minus 10% under all conditions of load. T.T. Cobra Tech and Biostat shall also be added to the system.
- F. After the system is flushed, pre-cleaned and chemically stabilized the Contractor shall:
  - 1. Turn the test kits over to the owner.
  - 2. Instruct the owner in proper maintenance procedures.
  - 3. Fulfill all obligations for the specified period of one (1) year from the date of start

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up including four (4) service calls during the cooling season and two (2) service calls during the heating season.

- G. Where the owner provides the chemicals for treatment, notify the owner well in advance of the cleaning process and when completed advise in writing that it is recommended that the chemicals be changed immediately to prevent damage to the system.

END OF SECTION 15220



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SECTION 15250  
INSULATION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 WORK INCLUDED

- A. Duct Systems Insulation.
- B. Piping Systems Insulation.
- C. Accessories.

1.3 QUALITY ASSURANCE

- A. All products within the conditioned air stream or active plenums shall comply with the NFPA 90A Flame/Smoke rating of 25/50 and comply with UL 181 erosion limitations. Fire hazard ratings shall be as determined by NFPA-255, "Method of Test of Surface Burning Characteristics of Building Materials" - ASTM E84 or UL 723.
- B. All adhesives, cements, finishes, jackets, etc., shall be UL listed or labeled for use as applied to insulation and designed specifically for use in the installation.
- C. All insulation shall be installed in accordance with National Commercial & Industrial Insulation Standards (NCIA).

1.4 SUBMITTALS

- A. Submit schedule indicating type of insulation, thickness, vapor barrier or coating by system and size.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Submit details of insulated removable covers using the actual equipment dimensions, concrete base sizes and piping arrangements.
- D. Refer to Division 1 requirements.

1.5 GENERAL REQUIREMENTS

- A. Factory-applied insulation is specified under the applicable equipment Section of these specifications. It is listed here for reference only.
- B. Packages and standard containers of materials shall be delivered unopened to job site and shall have the manufacturer's label attached giving a complete description of the material.

1.6 DEFINITIONS

- A. The term "exposed" means exposed to view in finished spaces, in equipment rooms, in fan rooms, in closets, in utility corridors, in tunnels, on roof, in storage rooms, and in other

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spaces as indicated.

- B. The term "concealed" means concealed from view, and includes all spaces not defined as exposed.
- C. The term "unconditioned" space shall mean all places where the temperature surrounding the pipe has not been conditioned consistent with conditioned spaces, and shall include mechanical equipment rooms, non-active ceiling plenums, and non-accessible chases. This term shall also include conditioned spaces where the humidity levels are allowed to rise above 70% RH.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fiberglass Insulation:
  - 1. Owens-Corning Fiberglas
  - 2. Knauf Fiberglass
  - 3. CertainTeed
  - 4. Johns Manville
- B. Closed Cell Elastomeric Insulation:
  - 1. Armacell LLC
  - 2. Johns Manville
  - 3. Rubatex
- C. Foamglass Insulation:
  - 1. Pittsburgh Corning
  - 2. Cell-U-Foam Corp.
  - 3. Owner Approved Equal
- D. Jackets:
  - 1. Southern Asbestos Company
  - 2. John Mansville
  - 3. Owens-Corning Fiberglas
- E. Insulation Coatings, Mastics, Adhesives, and Sealants
  - 1. Foster
  - 2. Childers
  - 3. Pittsburgh Corning
  - 4. Armacell

2.2 DUCT INSULATION AND FIREPROOFING REQUIREMENTS – Refer to Construction Documents.

2.3 MATERIALS

- A. Duct Insulation:
  - 1. Blanket Fiberglass: Flexible fibrous glass, flame retardant factory laminated foil-skrim-kraft (FSK) vapor barrier, 2" stapling flange, maximum vapor permeance

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of .02 perm/in., minimum density of 1.5 lb/cf, maximum conductivity per 1" thickness of .28 at 75°F mean temperature. Based on Knauf Duct Wrap or approved equal.

B. Pipe Insulation (to 450F):

1. Closed Cell Elastomeric (Small Pipe Sizes up to 5 Inches): Flexible, elastomeric, closed cellular, tubular molded to accommodate piping, smooth outer surface suitable for painting with vinyl lacquer type coating, water resistant, non absorbent, ozone resistant, minimum density of 4 lb/cf, maximum conductivity per 1" thickness of .27 at 75°F mean temperature. Based on Armacell LLC AP Armaflex and Self-seal Armaflex 2000 or approved equal.
2. Foamglas: Rigid, preformed sections of 100% rigid cellular glass complying with ASTM C552 standards, non-absorptive of moisture after immersion, water vapor permeability 0.00 perm/in. impervious to common acids (except hydrofluoric), non-combustible, 90 PSI compressive strength when capped with hot asphalt, 7.5 #/cu.ft. density, thermal conductivity 0.28 BTU-In./Hr./Sq.Ft./F @ 50°F. Based on Pittsburgh Corning Foamglas or approved equal.

C. Insulation Accessories:

1. Aluminum Pipe Jacket and Fitting Covers: Jacket shall be 0.016" thick (26 gauge) embossed aluminum, sized to provide a 2" (min.) lap joint both longitudinally and circumferentially, with 3/4" min. wide x 0.015" min. (30 gauge) thick draw bands. Fitting covers shall be aluminum, 0.025" (22 gauge), min., thickness.

D. Accessories:

1. Aluminum Pipe Jacket and Fitting Covers: Jacket .016" thick (28 ga.) embossed aluminum sized to provide a minimum 2" lap joint both longitudinal and circumferentially, minimum 3/4 inch x .015 inch thick (30 ga) draw bands. Covers .024 inch thick.
2. PVC pipe jacket and fitting covers used with insulation for pipe, elbows, tees, couplings, 25/50 flame/smoke ratings, suitable for temperatures to 500°F.
3. Glass Cloth Pipe, Duct and Equipment Jacket: Glass lagging cloth, 8 oz/sy treated weight. Secure with elastomeric insulating adhesive on elastomeric insulation, for fiberglass insulation use appropriate mastic finish as recommended by the insulation manufacturer with the perm rating of the mastic equal to or less than that of the insulation it is sealing.
4. Glass tape shall be a minimum density of 1.6 ounces per square yard, 4 inch wide with a 10 x 10 thread count per inch of width. Glass cloth shall be untreated.
5. Staples shall be outward clinching type, Type 304 or 316 stainless steel in accord with ASTM A 167 or Monel® coated or approved equal.
6. Wire shall be soft annealed galvanized, or copper, 16 gauge, or nickel copper alloy.
7. Closed cell elastomeric insulated finish shall be a white water based flexible, acrylic latex enamel equal to WB Armaflex finish.
8. Insulation Tape: Closed cell elastomeric insulation: 2" wide x 1/8" thick.
9. Elastomeric Insulation Adhesive: Air drying contact adhesive for securing sheets to flat or curved metal surfaces and joining seams and butt joints of elastomeric insulation. Suitable for temperatures to 180F, dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method.
10. Vapor Barrier Mastic: Air drying flexible water based mastic used for applying a vapor barrier joint with glass cloth at insulation joints. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Maximum Perm rating of

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0.08. , Childers Products Company, Inc. CP-35 Chil Therm® WB, Foster Products Corp. Product Data 30-80 Foster Vapor Safe® Coating, Marathon Industries, Inc. 590 LO-PERM, Richard's Paint Manufacturing CO., Inc. VBM-4, Vimasco Corp. 749 Vapor-Blok, or equal.

11. Acrylic Latex Finish and Sealers:
  - a. Elastomeric Insulations: Air drying flexible water based finish used for finishing flexible elastomeric insulation. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Armacell LLC WB Armaflex finish.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install all insulation in strict accordance with the manufacturers written installation instructions.
- B. All insulation work shall be performed by skilled mechanics regularly engaged in the insulation trade.
- C. Properly coordinate the insulation work with the other trades so that installation is performed with a minimum of conflict.
- D. Insulation shall not be applied on any piping or duct system requiring testing until testing is completed and approved by Owner's Representative.
- E. Insulation shall not be applied until all systems are clean, dry, free of dirt, dust or grease.
- F. The finished installation shall present a neat and acceptable appearance which includes but is not limited to: all jackets smooth, all vapor barriers sealed properly, no evidence of "ballooning" of the jackets, or sagging insulation, all valves, dampers, gauges, unions, etc. accessible. The Owner's Representative shall be the final judge of acceptance of workmanship.
- G. All equipment nameplates on hot equipment shall be left uncovered. All equipment nameplates on cold equipment shall have a removable section sized to expose the nameplate. This section shall be clearly marked "NAMEPLATE".
- H. If proper maintenance procedures require access to the insulated equipment removable panels, sections or covers shall be provided to accomplish this. These access devices shall be constructed in a manner to assure easy access and sturdy construction. The contractor shall assume the responsibility to coordinate all equipment requiring insulation to be either factory or field insulated.
- I. Insulation and accessories shall be applied only at suitable application temperature and conditions as recommended by the manufacturer. Do not apply insulation to any surface while it is wet.
- J. Insulation shall be protected from moisture and weather during storage and installation.
- K. Insulation which has sustained moisture damage, torn jackets, or other damage due to improper storage or other reasons shall not be used. If evidence of this is sighted the Owner's representative reserves the right to require the insulating contractor to remove any and/or all insulation until the Owner's Representative is satisfied that there is no longer

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any inferior insulation installed on this project.

- L. Insulation, fabric and jacketing shall be protected from damage during construction. Damage by the insulator shall be repaired without cost to the Owner. Damage by others shall be reported in writing to the contractor.
- M. The insulation subcontractor is responsible for proper material storage at the work site.
- N. Work performed prior to receipt of approved documents or submittals, later proving to be incorrect or inappropriate, shall be promptly replaced by the contractor without cost to the purchaser.
- O. Insulation shall not be installed until adequate access and clearances at control mechanisms, dampers, sleeves, columns and walls have been provided.
- P. All insulation at handholes, access doors or other openings, and adjacent to flanges and valves shall be neatly finished where exposed to view.
- Q. Where an insulated pipe or ductwork passes through a sleeve or opening in a non-rated partition, the full specified thickness of the insulation shall pass through the sleeve or opening. Where an insulated pipe or ductwork passes through a rated partition, the insulation shall be stopped at the partition. The void between the pipe and the sleeve shall be sealed with an approved fire-stopping material, and the insulation trimmed and sealed to the partition sufficient to cover the sleeve.
- R. All materials, accessories and methods of installation and fabrication are subject to the Owner's Representatives inspection and approval during any phase of the work.
- S. The insulation subcontractor shall prevent the accumulation of insulation debris in the buildings and on the premises of the Owner.
- T. The insulation subcontractor shall be responsible for his own safety program at the work site, and shall provide instruction on safe practices for his workers assigned to the project. All employees are subject to the work rules at the job site.
- U. The insulation subcontractor shall familiarize himself with the progress and execution of the job and notify the proper parties of interferences and any problems with the proper installation of his materials.

### 3.2 INSTALLATION

#### A. Duct Insulation:

##### 1. General:

- a. Insulate or internally line all flexible duct connectors equal to or greater than adjacent insulation thickness.
- b. The tops of all diffusers shall be insulated same as connecting ductwork to prevent condensation.
- c. Duct insulation at fire dampers shall be extended over supporting angle iron and sealed to wall.

##### 2. Blanket Fiberglass Insulation:

- a. Insulation shall be tightly wrapped on the ductwork with all circumferential joints butted and longitudinal joints lapped 2 inches and stapled. Joints

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shall be finished with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth. Additionally secure insulation to bottom of rectangular ducts over 24 inches wide with weld pins at no more than 18 inches on center.

- b. Insulation shall be butted with facing overlapping all joints shall be finished with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth. Breaks, punctures, pin penetrations in facing shall be sealed with vapor barrier tape and vapor barrier adhesive.

B. Pipe Insulation:

1. General:

- a. All locations where the insulated surface is supported by hangers, the insulation shall be protected by shields or saddles properly skimmed to maintain a smooth outer surface, and proper insulation thickness. If the possibility exists that the hanger may conduct the temperature of the conveyed medium and thus cause condensation or personal injury due to high temperature, the hanger shall also be insulated.
- b. All devices connected to or in line with the piping system shall be insulated greater than or equal to the connecting piping. This includes but is not limited to valves, air separators, expansion tanks, control valves, control devices, gauge connections, thermometer stems, chemical feed equipment, piping flexible connectors, etc.
- c. The insulation at threaded unions in hot water piping shall be tapered and terminated with cement and glass lagging cloth and lagging adhesives.
- d. Insulate exterior surfaces of all anchors and guides for chilled water piping systems.
- e. A complete moisture and vapor barrier shall be installed wherever insulation is penetrated by hangers or other projections through insulation and in contact with cold surfaces for which a vapor seal is specified.
- f. Cover fittings, flanges, unions, valves, anchors, and accessories with premolded or segmented insulation of the same thickness and material as the adjoining pipe insulation. Where nesting size insulation is used overlap pipe insulation 2 inches or one pipe diameter. Fill voids with insulating cement and trowel smooth. Elbows shall have not less than 3 segments per elbow. Secure insulation with wire or tape until finish is applied. Blanket inserts in lieu of premolded or segmented insulation is not allowed. Cover fittings with preformed PVC fitting covers.
- g. Wrap all pressure gauge taps, thermometer wells and all other penetrations through insulation with closed cell insulation tape so as to prevent condensation.
- h. Seal all raw edges of insulation.
- i. For piping supported by hangers outdoors, apply a rainshield to prevent water entry.

2. Closed Cell Elastomeric:

- a. All joints shall be sealed with adhesives.
- b. Where the thickness is to be obtained by use of two layers of insulation,

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- install with staggered joints.
  - c. Finish:
    - 1) Concealed Indoors: No additional finish.
    - 2) Exposed Indoors: Provide PVC jacket over all insulation.
    - 3) Concealed Indoors: Provide PVC jacket over fittings fabricated from insulation sections or sheet.
    - 4) Outdoors: Provide aluminum pipe jacket.
- 3. Foamglas:
  - a. Below ambient piping: All joints, both longitudinal and circumferential shall be sealed with an insulation joint sealant.
  - b. Thickness shown for refrigeration pipe to be obtained by use of two layers of insulation with staggered joints.
  - c. Above ambient piping finish: Weather barrier breather mastic. Foster 46-50, Childers CP-10 or Pittcote 404
  - d. Below ambient piping finish:
    - 1) Before PVC jacket is used, seal all insulated elbows, fittings, and valves with vapor barrier coating and reinforcing mesh.
    - 2) Exposed Indoors: Provide PVC jacket over all insulation that shall be sealed with an acrylic latex finish.
    - 3) Concealed: Provide PVC jacket over fittings fabricated from insulation sections or sheet. Provide ASJ over all other. Vapor seal ASJ with vapor barrier coating.
    - 4) Exposed Outdoors: Provide acrylic latex finish and aluminum pipe jacket.
- D. Aluminum Pipe Jacket:
  - 1. Provide aluminum jacket over all exposed pipe insulation located outdoors.
  - 2. Align all seams.
  - 3. Securing shall be with 3/4" wide draw bands. Maximum band spacing 18" on center.
  - 4. All openings and voids shall be sealed air and water tight.
- E. PVC Jacket:
  - 1. Provide PVC sheet jacket over all exposed, indoor piping or insulation.
  - 2. Provide PVC pipe jacket over all exposed, indoor elastomeric pipe insulation.
  - 3. Provide PVC fitting covers over all fittings fabricated from insulation sections or sheet material.
  - 4. PVC pipe jacket shall be applied with special attention given to achieving positive seal at all longitudinal and circumferential joints using a welding solvent on the longitudinal joint as recommended by the manufacturer. Slip joints to have 4" minimum lap and no welding solvent.
- F. Glass Cloth Jacket:
  - 1. Provide where specified.
  - 2. Provide acrylic latex finish.
- G. Flexible Acrylic Latex:
  - 1. Apply two coats to closed cell elastomeric insulation.

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2. Refer to Division 9 for color to be used. If no instructions are given, provide a white finish.

3.3 MISCELLANEOUS ITEMS

- A. General: Provide insulation of any portion of a system or piece of equipment not previously discussed where ambient operating conditions will allow condensation to occur or whose surface temperature exceeds 115°F. Insulation materials and method shall be as directed by the Designer.
- B. Final Inspection: At final inspection, the finished surfaces of all exposed insulation shall be clean and without stains or blemishes. Repair and clean the insulation surfaces and, if necessary, to obtain a new appearance, shall coat discolored surfaces with off-white latex water-base semi-gloss paint or lagging adhesive, without a change in the contract price.

END OF SECTION 15250



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SECTION 15673  
AIR COOLED LIQUID CHILLER

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Section includes design, performance criteria, controls and control connections, chilled water connections, electrical power connections and refrigerants of the chiller package.

1.3 REFERENCES

- A. Products shall be designed, rated and certified in accordance with applicable sections of the following Standards and Codes:
  - 1. To comply with the most recent versions of applicable Standards and Codes of AHRI 550 / 590.
  - 2. AHRI 370 - Standard for Sound Rating of Large outdoor Refrigerating and Air-conditioning Equipment.
  - 3. To comply with the most recent versions of applicable Standards and Codes of ASHRAE 15.
  - 4. Units shall meet the efficiency standards of the latest ASHRAE 90.1 Standard.

1.4 QUALITY ASSURANCE

- A. UL 1995 -- Standard for Heating and Cooling Equipment.
- B. Manufactured facility to be ISO 9001.
- C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with HFC-410A refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors.
- D. Chiller manufacturer shall have a factory trained and supported service organization that is within a 50 mile radius of the site.
- E. Warranty: The manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen months from date of shipment; whichever occurs first.
- F. Starting of Mechanical Systems:
  - 1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
  - 2. Provide labor to assist the Owner's Representative in acceptance review.
  - 3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
  - 4. Provide information and assistance and cooperate with test, adjust and balance services.
  - 5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.

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6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of final completion.

1.5 SUBMITTALS

- A. Submit dimension drawings, performance and product data for acceptance.
- B. Submittal shall include certified performance data at specified design conditions; complete dimensional data on the chiller and starter; control and wiring diagrams showing integration with all necessary equipment as designed for this project; schematic diagram showing recommended auxiliary piping as may be required for the motor, oil cooler or purge if required. If the equipment layout, size or pass arrangement is materially different than that shown on the Contract Documents, a complete piping and equipment layout shall be included. The controls are to be integrated with controls furnished and installed by the temperature control manufacturer. It shall be the responsibility of the chiller manufacturer to completely coordinate these controls so as to provide safe and proper operation of the chiller. Projected sound pressure ratings in each octave band shall also be included in the submittal.
- C. Submit letter of certification as described in 1.3; QUALITY ASSURANCE.
- D. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- E. Operation and maintenance data - Include manufacturer's descriptive literature, installation checklist, start-up instructions and maintenance procedure.
- F. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Unit controls shall be capable of withstanding 150°F storage temperatures in the control compartment.
- B. Unit shall be stored and handled per unit manufacturer's recommendations.
- C. Units shall be delivered to job site fully assembled and charged with refrigerant (unless selected with nitrogen charge) and oil by the manufacturer.
- D. During shipment, provide protective covering over vulnerable components. Fit nozzles and open pipe ends with enclosures.

1.7 WARRANTY

- A. Provide a full parts & labor warranty for 60 months from start-up or 66 months from shipment, whichever occurs first.
- B. The warranty items include but are not limited to the following:
  1. Whole Units Parts Warranty
  3. Whole Unit Labor Warranty
  5. Refrigerant Warranty
- C. Provide an extended compressor parts only warranty for a total of 120 months.

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1.8 MAINTENANCE SERVICES

- A. Provide a full chiller maintenance service 24 months from substantial completion.
- B. All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.
- C. OEM shall provide and report quarterly, annual, and bi-annual maintenance in compliance with or better than ASHRAE Standard 180-2008.
- D. Include maintenance items as recommended in manufacturer's operating and maintenance data.
- E. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Carrier
- B. Trane (Model CGAM Basis of Design)
- C. Johnson Controls

2.2 GENERAL UNIT DESCRIPTION

- A. Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the package shall be all factory wiring, piping, controls, and refrigerant charge (HFC-410A).

2.3 CABINET

- A. Frame shall be heavy-gage, with a powder coated paint finish for both aesthetic appeal and to offer more resistance to corrosion.
- B. Units shall be constructed of a galvanized steel frame with galvanized steel panels and access doors. Component surfaces shall be finished with a powder-coated paint. The coating or paint system shall withstand a 1000-consecutive-hour salt spay application in accordance with standard ASTM B117.

2.4 COMPRESSORS

- A. Fully hermetic scroll type compressors with R410A optimized and dedicated scroll profile.
- B. Direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency.
- C. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

2.5 EVAPORATOR

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- A. The evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.
- B. The evaporator shall be protected with an etched foil heater and insulated with 1-1/2 inch insulation. This combination shall provide freeze protection down to -20F ambient temperatures while the heater is powered. Contractor shall provide separate power to energize heater and protect evaporator while chiller is disconnected.
- C. The water side working pressure shall be rated at 150 psig and tested at 1.5 times maximum allowable water side working pressure.
- D. The refrigerant side working pressure shall be rated at 460 psig (29.6 bars) and tested at 1.1 maximum allowable refrigerant side working pressure

2.6 CONDENSER

- A. The condenser coils shall consist of copper tubes mechanically bonded into plate-type aluminum fins. A subcooling coil shall be an integral part of the main condenser coil.
- B. The maximum allowable working pressure of the condenser shall be 650 psig (44.8 bars). The condensers shall be factory proof and leak tested at 715 psig (49.3 bars).
- C. Low Sound Fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise fan blade.
- D. Low speed fan motors shall be three-phase with permanently lubricated ball bearings and individually protected by circuit breakers.
- E. Unit shall be capable of starting and running at outdoor ambient temperatures from 32F to 125F (0C - 52C) for all sizes.
- F. Provide a complete, flexible epoxy dip and back coating of condenser coils. Coil with coating shall be able to handle 5,000-hour sales spray test. All coil surfaces shall be coated with epoxy material giving uniform coverage (minimum of 0.8 mils), without bridging between fins. Any coating showing bridging will be unacceptable. Coatings not covering any part of the fin and/or parts of condenser frame will be unacceptable. Backed phenolic coatings are unacceptable because of their brittle nature. The heat transfer decrease due to the coating shall be less than 1% so that design capacity and efficiency are maintained. Coating shall be able to withstand corrosive environments in the pH range of 3 - 12. Coating shall be flexible so that bare surfaces will not form. The coating shall be able to handle temperatures ranging from -50 F to 150 F without degradation. UV protection shall be applied on surface of coating to prevent degradation from sunlight.

2.7 ENCLOSURES

- A. Mount starters in a UL1995 rated panel for outdoor use.
- B. The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.
- C. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

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- D. Control panel shall be dead front construction for enhanced service technician safety.
- E. Power line connection type shall be standard with a terminal block.

2.8 REFRIGERATION COMPONENTS

- A. Each refrigerant circuit shall include a filter drier, electronic expansion valve with site glass, liquid line service valves and a complete operating charge of both refrigerant HFC-410A and compressor oil.
- B. Each refrigerant circuit shall include a discharge line service valve to allow the refrigerant to be isolated in the condenser.

2.9 CONTROLS, SAFETIES AND DIAGNOSTICS

- A. The microprocessor-based unit controller shall be factory-installed and factory-tested.
- B. The unit display shall provide the following data:
  - 1. Water and air temperatures
  - 2. Refrigerant levels and temperatures
  - 3. Flow switch status
  - 4. Compressor starts and run times
- C. The unit controller shall provide chilled water reset based on return water as an energy saving option.
- D. The unit shall shut down if one or more of the following safeties has been breached:
  - 1. Low evaporator refrigerant temperature and/or pressure
  - 2. High condenser refrigerant pressure
  - 3. Low oil flow
  - 4. Motor current overload
  - 5. High compressor discharge temperature
  - 6. Electronic distribution faults: phase loss, phase imbalance, or phase reversal
- E. Unit shall be shipped with factory control and power wiring installed.
- F. Chilled Fluid Circuit -- with optional integrated evaporator water pump
- G. Chilled fluid circuit shall be rated for 150 psig (1034 kPa) working pressure.
- H. Proof of flow switch shall be factory installed the correct number of pipe diameters from any elbow and in the correct orientation. In addition, the flow switch shall be factory wired.
- I. A water strainer shall be factory provided and installed with a blowdown valve to facilitate periodic cleaning of the strainer to prevent it from becoming clogged.
- J. Building Control System Interface:
  - 1. The chiller manufacturer shall provide a communication interface that shall permit complete exchange of chiller data with any BAS system specified in Section

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15900 through the use of an BACnet translator. The BACnet translator shall allow the BAS system to issue commands to the chiller to control its operation, change set points, and report all data to the BAS system that is normally available to an integrated control system.

2. The microcomputer control center shall also have the following points hardwired in conjunction with the BACnet Points:
  - a. Remote chiller start/stop.
  - b. Reset of chilled water temperature.
  - c. Reset of current limit.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install in strict accordance with manufacturers written installation instructions.

3.2 MANUFACTURER'S FIELD SERVICES

- A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
- B. Included OEM Factory Startup:
  1. Scroll Chillers
  2. Applied Chiller manufacturers shall maintain service capabilities no more than 50 miles from the jobsite.

END OF SECTION 15673

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SECTION 15740  
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Single Duct VAV Terminal Units.
- B. Electric Heating Coils.

1.3 QUALITY ASSURANCE

- A. All units shall be suitable for use in a return air plenum.
- B. All components within the air stream shall conform to the NFPA 90A Standard for Flame/Smoke/Fire Contribution of 25/50/0.
- C. All units shall be the product of a manufacturer regularly engaged in the production of terminal units and all supplied units shall be clearly described by means of published catalog data from the same manufacturer.
- D. All units shall be capable of maintaining their minimum and maximum set points within a maximum of  $\pm 5\%$ .
- E. Include letter with submittal data stating that unit controls have been completely coordinated with controls contractor.
- F. Terminal box manufacturer shall completely coordinate the controls provided on or required by the box with the control package provide under Section 15900 – Building Controls System.
- G. Starting of Mechanical Systems:
  - 1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
  - 2. Provide labor to assist the Owner's Representative in acceptance review.
  - 3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
  - 4. Provide information and assistance and cooperate with test, adjust and balance services.
  - 5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
  - 6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.
- H. Sound Power Data: Manufacturers shall submit sound power data for each comparable size terminal box listed. Sound levels at any speed, at any box, shall not exceed the listings below. The data taken as measured at a distance of one foot from any point on the terminal box. Based on minimum inlet static pressure +0.5" w.g.

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	125 Hz	250 Hz	500 Hz	1K	2K	4K
Discharge	73	69	67	64	64	61
Radiated	68	64	57	52	50	44

1.4 SUBMITTALS

- A. Submit dimension drawings, performance and product data for acceptance. Include listing of discharge and radiated sound power level for each of second thru sixth octave band for inlet pressures of 1 inch w.g. Include listing of control air requirements, if applicable.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Single Duct VAV Terminal Boxes:
  - 1. Environmental Technologies, Inc.
  - 2. E.H. Price Company
  - 3. Krueger
  - 4. Nailor Industries, Inc.
  - 5. Titus
  - 6. Trane
  - 7. Metal\*Aire
- B. Electric Heating Coils:
  - 1. Environmental Technologies, Inc.
  - 2. E.H. Price Company
  - 3. Krueger
  - 4. Nailor Industries, Inc.
  - 5. Titus
  - 6. Trane
  - 7. Metal\*Aire

2.2 FABRICATION

- A. Single Duct VAV Terminal Units:
  - 1. Unit casing: galvanized steel, fully lined with 1 in. thick, 1-1/2 lb./cu. ft. density, nylon scrim reinforced foil skin vapor barrier insulation. Insulation shall be dual thermal/acoustical fiberglass insulation meeting NFPA 90A requirements, UL 181 erosion control requirements, meet all requirements of ASTM C1071 (including C665), sand carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and have a R-value of 4.2. All cut edges of insulation shall be sealed by a heavy adhesive seal to prevent fibrous material from entering the airstream. A special sheet metal picture frame bracket may be used to enclose the liner of the discharge end to prevent the liner from dislodging under extremely high pressure conditions and to prevent damage during installation. Casing shall have access doors or panels suitable for equipment service. Insulated damper with leakage not to exceed 2% of design flow at 3.0" w.g. All joints sealed with



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- adhesive as required. Unit to have air inlet collar and flanged or slip and drive discharge connection.
2. Pressure Independent Air Volume Control Consisting of the Following:
    - a. Factory calibrated damper assembly having maximum 4% leakage at 4.0" w.g.
    - b. Multi-point velocity sensor.
    - c. 24V, 40VA control transformer.
    - d. Coordinate with DDC control package provided under Section 15900 – Building Automation System.
- B. Electric Heating Coil:
1. Tested with the terminal box in accordance with UL and ETL standards. Meet all NEC requirements. UL Listed.
  2. NEMA 1 electrical enclosure with single point connection for heater and box. Wiring diagram with specific wiring for each unit included with unit.
  3. Automatic reset thermal cutouts for each element, nickel chrome heating element, magnetic disconnecting contactor for each step of control, line and control terminal blocks, interlocking, disconnect, main supply fuses, positive pressure air flow switch, 24 V control transformer. Coordinate with DDC control package provided under Section 15900 – Building Automation System.
  4. Galvanized steel casing with flanged or drive and slip connection.
  5. Heating coil integral with terminal unit, and the heating coil shall be internally wired in such a manner that assures that a balanced electrical load will be provided across all three phases of the load at all times.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install in accordance with manufacturer's written installation instructions.
- B. Support terminal box independent of ductwork.
- C. Install terminal boxes to provide maximum clearance for electrical and maintenance access.
- D. Coordinate the terminal box controls with the building control system contractor to ensure that all miscellaneous accessories required for proper operation are included and that the direct/reverse action normally closed/normally open functions are properly coordinated.
- E. If terminal boxes are installed in areas where access to controls thru a lay-in or removable ceiling is not possible, coordinate the locations of access doors thru the ceiling.
- F. Be sure minimum and maximum CFM settings agree with the requirements of the terminal unit schedule.
- G. Provide rigid metal straight duct equal to four diameters on inlet of all terminals.
- H. Provide transitions from duct size to terminal inlet or outlet size as required.
- I. Provide flexible duct connection at outlet plus a minimum of 12" and a maximum of 36" of straight flexible duct upstream of rigid duct at inlet.

END OF SECTION 15740

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SECTION 15763  
PACKAGED AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Refer to Division 1 for all requirements pertaining to General Provisions.

1.2 WORK INCLUDED

- A. Packaged Air Handling Units.

1.3 QUALITY ASSURANCE

- A. All electrical components shall be listed and labeled by U.L., ETL or a Nationally Recognized Testing Laboratory (NRTL), listed and labeled.
- B. Unit performance shall be certified in accordance with ARI Standard 430 for central station air handling units.
- C. Coil performance shall be certified in accordance with ARI Standard 410.
- D. All components in the conditioned air stream shall conform to the NFPA-90A Flame/Smoke/Fire Contribution Rating of 25/50/0.
- E. All electrical devices shall conform to NEMA standards.
- F. All wiring shall conform to the NEC.
- G. When connected to a 277/480 VAC system, the heating coil shall be listed and labeled at 277 VAC or 480 VAC for single phase or three phase units respectively, regardless of the voltage scheduled on the drawings.
- H. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.
- I. After installation the manufacturer's representative of all equipment provided in this section shall certify in writing to the Owner's Representative that the equipment has been assembled and installed within the guide lines of the manufacturer's written installation instructions and that its performance meets or exceeds the operating characteristics, specified and/or scheduled.
- J. In accepting this Contract, the air handling unit manufacturer shall guarantee their units to give capacities not less than the capacities specified with the conditions as specified, without the unit sweating in an unconditioned mechanical room, (it is understood that minor misting of the unit surface may occur at unit seams where thermal breaks do not exist. The manufacturer guarantees that they will take whatever steps are necessary to meet the guarantee, at no additional cost to the Owner, regardless of the extent of the revisions required. A Corporate Officer of the manufacturer shall certify the guarantee and the submittal data.

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- K. The work shall include a one-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material which has been furnished at no cost to the Owner for a period of one year from the date of substantial completion of System. Extended warranty shall be provided for systems installed during earlier phases of construction through to substantial completion of the final phase. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the Owner upon project completion.
- L. Starting of Mechanical Systems:
1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
  2. Provide labor to assist the Owner's Representative in acceptance review.
  3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
  4. Provide information and assistance and cooperate with test, adjust and balance services.
  5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
  6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.

1.4 SUBMITTALS

- A. Submit in accordance with Division 1 requirements.
- B. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.
- C. AHU manufacturer shall provide the following information with each shop drawing/product data submission:
1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
  2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
  3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
  4. All performance data, including capacities and airside pressure drops, for components.
  5. Fan curves shall be provided for fans with the design operating points indicated and at 15% greater RPM along the system curve with fan efficiency and horsepower clearly indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
  6. Submit computer coil selection clearly indicating system design conditions, as well as coil hand connections, electric heating coil data, where applicable.
  7. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.

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8. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
9. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
10. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

D. The AHU manufacturer shall list any exceptions to the specification.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Packaged Air Handling Units:

1. Carrier
2. McQuay
3. Trane

### 2.2 FABRICATION

A. Packaged Air Handling Units:

1. General:

- a. Sizes, types and performance as indicated on unit schedule.
- b. Each unit complete with factory furnished components as shown on the plans. Each air handler unit shall be completely factory assembled, or partially assembled, tested and shipped in one piece or in sections for field assembly depending on size. All casings and access doors shall be of double wall construction. All components shall be assembled on a base rail or mounting legs of sufficient height to provide proper condensate drain trapping, provided with the unit, complete with lifting lugs to accept cable in chain hooks.
- c. All units shall have decals and tags to indicate caution areas and to aid unit service. Nameplates shall be fixed to the unit.

2. Cabinet, Casing and Frame:

- a. Full height, hinged access doors with stainless steel hinge and lever latching mechanism shall provide access to each cabinet section from both sides. Access doors shall provide gasketing for a positive seal. Doors shall open outward for negative pressure and inward for positive pressure applications, or have a double latching mechanism for safety.
- b. Unit shall be insulated with U.L. listed minimum 2" thick waterproof foam insulation. Insulation to have a minimum thermal resistance or "R-Value" of 13.
- c. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8" w.g., whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).

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- d. Casing air leakage shall not exceed 1% of design airflow at the specified casing pressure.
- e. Exterior panels of all sections shall be constructed of 18 gauge or heavier galvanized steel. All sections shall include galvanized steel internal liners. Wall thickness shall be 2".
- f. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

3. Access Doors:

- a. Access doors shall be 2" double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
- b. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.
- c. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- d. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- e. Handle hardware shall be designed to prevent unintended closure.
- f. Access doors shall be hinged and removable without the use of specialized tools to allow.
- g. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- h. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
- i. All doors shall be a minimum 60" high when sufficient height is available, or the maximum height allowed by the unit height.
- j. A single door handle shall be provided for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit.
- k. A shatterproof window shall be provided in fan access doors.

4. Coil Sections:

- a. Coil sections shall be blow thru or draw thru as scheduled or detailed on drawings and incorporate single or multiple coils. Coils shall be guaranteed to have no moisture carry-over.
- b. Coil row depth shall match that shown on the air handling unit schedule, except that the minimum row depth shall be that listed, or 8 rows, whichever is less. Maximum fin density shall be 130 fins per foot, regardless of the value scheduled.
- c. Direct expansion coil shall have sweat-type connections located on the same end. Coil headers, distributors and connections shall be completely enclosed in the unit casing. Coil supports shall be Type 304 stainless steel.
- d. Coils shall have non-ferrous headers and copper tubes, mechanically bonded to ripple-corrugated aluminum fins. Coils shall have a staggered tube type design. Coils shall have Type 304 stainless steel casing. Coils shall be certified in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard 410-72. Coil performance shall be substantiated by computer generated output data.
- e. Chilled water coils shall have 1/2" or 5/8" O.D. copper tubes. Coils shall be circuited for minimum pressure drop. Coils shall be tested at 315

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pounds air pressure under warm water and be guaranteed for 150 psig working pressures. Coils shall be guaranteed to produce no carryover.

5. Condensate Pan:
  - b. A double wall condensate drain pan consisting of inner 18 gauge 304SS pan, an outer 18 gauge galvanized steel pan and minimum 5/8" thick rigid foam insulation between the two pans.
  - c. Pan shall be non-trapping design sloped to the drain connection and guaranteed not to have standing water after shut-down. It shall extend beyond the leaving airside of the cooling coil and extend underneath the coil connections.
  - d. The drain pan shall be thermally isolated from the unit casing. A threaded drain connection shall extend through the unit base.
  
6. Supply Air Fan Section (Refer to Drawing Schedule):
  - a. Supply fans shall be double width, double inlet centrifugal type. All fans shall be statically and dynamically balanced for quiet operation. Forward curved fan wheel and housing shall be fabricated from painted cold rolled steel or continuous galvanized steel. Backward curved or Airfoil fan wheels shall be fabricated from aluminum, painted steel, or aluminum alloy with fan blades continuously welded to the back plate and end rim and shall operate in a continuous galvanized steel housing. Units shall have solid steel shafts mounted in heavy-duty 200,000 hour greasable ball bearings. Lubrication lines for the fan bearings shall be extended to the drive side of the unit and shall be copper only. The entire fan assembly shall be completely isolated from the unit bulkhead with vibration absorbing fan discharge seal and mounted on 2" deflection spring isolators for all units above 3,000 CFM capacity. For units 3,000 CFM and less, 1" deflection internal or external spring isolators may be provided.
  - b. Fans shall be forward curved, backward curved or Airfoil as scheduled.
  - c. The units shall be rated for an RPM 15% greater than that required at the point of selection. If necessary, heavier class construction is to be provided.
  - d. Fans for blow-thru applications shall incorporate a discharge diffuser.
  - e. Fan motors shall be heavy duty, high efficiency, 1800 RPM, open drip-proof type with greasable ball bearings as specified in Section 23 05 13. The motor shall be provided with have a fixed pitch drive rated to provide 1.4 service factory and be mounted on an adjustable base for proper alignment and belt tension adjustment. Variable volume control will be by adjustable frequency drive as specified in Section 23 05 17.
  
7. Filter Section:
  - a. The filter section shall be capable of accepting 2"- 30% pre-filters. They shall be supplied complete with galvanized steel filter racks as an integral part of the unit.
  - b. Provide fixed filter block-offs as required to prevent air bypass around filters.
  - c. Filters shall be accessible from both sides of the unit or as shown on the documents.
  - d. The filter section shall be provided with filters and filter differential pressure gauge (refer to controls drawings) as specified in Section 15880.

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8. Return Air/Outdoor Air Mixing Section:
  - a. A return air plenum shall provide 100% return air capability. A duct collar shall accept return air ductwork return air connection as detailed on drawings.
9. Factory Plenum Section Casing: Reinforced mill galvanized or primed steel with baked finish, minimum 18 ga. panels, gasketed joints between panels, 1" thick, 3 lbs. density glass fiber insulation with vapor barrier, access doors with safety latch handles. Suitable for 6.0" w.g. positive or 4" w.g. negative static. Field Built Plenums are NOT acceptable.
10. Discharge Air Plenum: A discharge air plenum shall be provided for sound attenuation with outlet velocities as scheduled and will have 1" duct collar for a bottom or front supply air duct connection as detailed.

PART 3 - EXECUTION

3.1 GENERAL

- A. Indoor floor mounted units shall be installed on 6" supports on neoprene pads on existing mezzanine. AHU shall be elevated above floor to allow for existing condensate piping to remain.
- B. Install 6" manufacturer base rail to allow for condensate trapping.
- C. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.
- D. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.
- E. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- F. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.
- G. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.
- H. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance, filter replacement, coil, fan shaft and motor removal with minimum disturbance of piping.
- I. Mount units at proper elevation and arrange condensate trap for proper drainage at design pressure differential. Pipe condensate to nearest floor or roof drain.

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- J. Install air vents and drain valves to permit proper venting and drainage.
- K. Prior to unit start-up all controls shall be installed and tested.
- L. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.
- M. All joints or assembled seams of the assembled unit shall be caulked or gasketed air tight up to 1.5 times design static pressure, or 8" w.g., whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).
- N. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.

END OF SECTION 15763



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SECTION 15840  
SHOP FABRICATED DUCTWORK

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

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

1.2 WORK INCLUDED

- A. Galvanized Steel Rectangular Ductwork.

1.3 QUALITY ASSURANCE

- A. All ductwork shall be fabricated within the guidelines established by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition.
- B. All ductwork shall be fabricated to withstand the pressure and velocity required on this project.
- C. All components, fasteners, sealants, adhesives, etc. in the conditioned air stream or exposed in active or non- active plenums shall conform to the NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems and Standard for Flame/Smoke/Fire Contribution of 25/50/0.
- D. All ductwork shall conform to UL standard UL 181 Factory Made Air Duct Materials and Duct Connectors, latest edition. Applicable sections shall apply to shop fabricated ductwork.
- E. After fabrication and installation of all shop fabricated ductwork the fabricator and installer, if not the same, shall certify in writing to the Owner's representative that all shop fabricated ductwork and installation of same meets or exceeds the quality standards established by SMACNA.

1.4 SUBMITTALS

- A. Submission for acceptance is required.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 requirements.

1.5 SHOP DRAWINGS

- A. Shop Drawings: Provide shop drawings of sheet metal ductwork as follows:
  - 1. Draw to a scale of not less than 1/4 inch to one foot on the same size sheets as the contract drawings.
  - 2. Show duct sizes.
  - 3. Show fitting details.
  - 4. Show lighting and ceiling diffusers.
- B. Shop Drawings for Field Erected Casings: Submit shop drawings for air handling unit

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casings, field erected casings and plenums.

1. Draw to scale of 1/2 inch to 1 foot on the same size sheets as the contract drawings.
  2. Show plan, sections, elevations and details of all joints and casings.
  3. Detail access doors and hardware.
  4. Detail coil, damper, humidifier, filter and fan installations. Provide access doors.
- C. Floor Plans: Provide sheet metal floor plans drawn to the same scale as the contract drawings.
1. Use contract drawing sheet size.
  2. Show on each floor plan the floor penetrations, fire dampers and access doors, ducts with sized and bottom elevations, terminal types and air quantities.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. Galvanized Steel Ductwork:

1. Interior, exposed or concealed: Hot rolled steel continuously annealed and hot dipped galvanized sheet or coil, minimum G-90, 0.90 oz/sf coating suitable for forming without flaking or peeling, suitable for welding or soldering. Zinc coating shall not be impaired from double seaming, breaking or roll forming. 14 ga. and lighter conforming to ASTM A 653. 13 ga and heavier conforming to ASTM A 653.
  2. Exterior or Areas Requiring Painting: Hot rolled steel continuously annealed and hot dipped galvanized sheet or coil, minimum G-90, 0.90 oz/sf (.001 inch thick/side) coating with a mill applied phosphate film suitable for insulating the paint from the drying action of the zinc, capable of forming without flaking or peeling, suitable for welding or soldering. Zinc coating shall not be impaired from double seaming, breaking or roll forming. 14 ga. and lighter conforming to ASTM A 653. 13 ga. and heavier conforming to ASTM A 653.
- B. Duct Sealants: Provide sealants with a maximum 25 flame spread, and maximum 50 smoke in the dry state, conforming to ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials", and fire resistive and non-flammable in accordance with ASTM D 93, "Standard Test Methods for Flash Point" by "Pensky-Martens Closed Tester", when wet.

### 2.2 FABRICATION

#### A. Galvanized Steel Ductwork:

1. Fabricate ductwork as indicated on the drawings. Sizes given are inside clear dimensions. Unless otherwise indicated on the drawings, the metal gauge shall be in accordance with SMACNA-HVAC Duct Construction Standards - Metal and Flexible, Latest Edition.
2. Elbow Fabrication:
  - a. 90 deg. elbows 12" or less in width shall be radiused whenever possible.
  - b. All radiused elbows shall be full radiused (R=1.5).
  - c. All mitered 90 deg. elbows shall have turning vanes. Ducts with a width/depth ratio of 1 or more shall have double thickness turning vanes; single thickness is permissible for less than 1.
3. Tee or Take-off Fabrication:

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- a. Take-off to round run-outs shall be conical or bell mouth. Where conical or bellmouth fittings can not be used due to take-off size to main, provide factory fabricated side takeoff fitting equal to Flexmaster U.S.A., Inc. Type "STO". Provide with handle extension for insulated ducts to clear the insulation thickness specified.
  - b. Take-off to square or rectangular shall be 45 deg. clinch collar or proportional divisions.
  - c. A volume damper shall be located downstream of each take off on square and rectangular take-offs, and integral to round run-outs.
4. Transitions:
- a. Concentric Transition: Maximum angle 45 deg. diverging, 60 deg. converging (SMACNA Fig. 2-7).
  - b. Eccentric Transition: Maximum angle 30 deg. diverging or converging (SMACNA Fig. 2-7).
5. At the Contractor's option, ductwork may be joined at the transverse joints with prefabricated galvanized Ductmate Industries, Inc. ("25" or "35") or Ward Industries, Inc. sections, or with fabricated TDF or TDC T-24 type flanged transverse joints with bolted corners, gaskets, and sealants, constructed in accordance with the SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, Table 1-12. Ductmate "25" may be used only on ductwork with a pressure classification of 2" w.g. or less on the discharge side of air handling units or fan power terminal units. Plastic joint clips are not acceptable. Flanged and prefabricated joints by different manufacturers shall not be jointed. Formed on flanges shall not be used.
- B. Ductwork, General: Each duct section shall have both ends covered with polyethylene or other suitable material to protect against the entrance of dirt, debris or water during shipment and storage prior to installation.

### PART 3 - EXECUTION

#### 3.1 GENERAL REQUIREMENTS

- A. Install in strict accordance with the Sheet Metal and Air Conditioning Contractor's National Association, Inc.'s (SMACNA) recommendations.
- B. The drawings, due to their small scale, are diagrammatic in nature and are not necessarily complete in all details. For this reason not all necessary offsets, risers or falls are shown. Coordinate the installation of the ductwork with all other trades and to provide all necessary offsets, etc. as required for completion of this project without any additional cost to the Owner and/or Engineer.
- C. All ductwork shall be run parallel or perpendicular to building structure whenever possible.
- D. All ductwork shall be properly sealed.
- E. Coordinate the location, provide the necessary access and install all devices provided in other specification sections within Division 15. Including but not limited to fire, smoke and/or balancing dampers, access and mounting for control devices, air flow measuring stations, etc. as apply to this project.
- F. All ducts passing through partitions or walls shall pass through at a 90 degree angle. The duct shall be sleeved with the space between the sleeve and duct properly sealed with

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firestopping material (Refer to Division 7 for Firestopping materials). The sleeve shall be permanently affixed to the wall (see Section 15090: Supports, Hangers, Anchors and Sleeves for sleeve specifications).

- G. Coordinate the proper duct pressure classification with the systems served and to construct the ductwork to withstand these pressures. (See 3.6 Schedules; System Pressure Classification and Duct Material Schedules.)
- H. All ducts located outdoors and not of welded construction shall have seams and transverse joints sealed water tight with duct sealer, arranged to shed water and finished with insulating duct coating as specified in Section 15860 - Sheet Metal Specialties.

### 3.2 CLEANING AND PROTECTION

- A. During construction, ductwork shall be cleaned of dirt and debris internally section by section as it is installed. At end of each day, ductwork not finally connected to equipment shall be provided with a temporary closure of polyethylene film or other covering material that will prevent entrance of duct, debris or water. Clean exterior surfaces of any material which might cause corrosion or if the duct is to be painted, it shall be cleaned suitable for painting. After substantial completion of the ductwork system, the system shall be operated with filters in place to blow-out any remaining dust from the system. Protect all equipment and property from damage or fouling during this cleaning. All prefilters used during cleaning shall be replaced prior to turning the system over to the Owner.

### 3.3 DUCT SEALING REQUIREMENTS

- A. All ducts shall have SMACNA Seal Class A (all transverse joints, longitudinal seams and duct wall penetrations).

### 3.4 LEAK TESTING

- A. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater within their scope of work) operationally air-tight, with no more than 2% leakage for duct systems rated at 2" w.c. pressure class, and 1% leakage for systems exceeding 2" w.c. pressure class. Leakage test to be performed by Contractor with all air device openings and fan connections sealed airtight. Test the systems prior to applying any insulation or concealing in soffits or chases. Use a portable fan capable of producing a static pressure equal or greater than the duct test pressure. This fan to have a flow measuring assembly consisting of a straight section of duct with an orifice plate, pressure taps, and a calibrated performance curve for determining leakage rates.
  1. Test each section equal to the external static pressure indicated for that fan or air handler with the portable fan assembly. After the fan achieves that steady state design pressure, record the air flow quantity across the orifice and the percent of design air flow. If the test fails, the Contractor shall reseal and retest at no additional cost to the Owner.
  2. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.
  3. Submit duct leakage reports to the Balancer and the Engineer for their review and approval.
  4. Refer to specification section 15051 for more information.

### 3.5 INSTALLATION

- A. Galvanized Steel Ductwork:

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1. Install ductwork as indicated on the drawings. If any conflict occurs notify the Owner's Representative prior to any extensive rerouting.
2. Install ductwork to allow clearance for the installation of duct insulation.

3.6 SCHEDULES

A. System Pressure Classification and Duct Material Schedule for Shop Fabricated Ductwork:

	<u>System</u>	<u>Section</u>	<u>Maximum Pressure</u>	<u>Duct Material</u>
3.	Supply To Terminal	A.C Unit	3" pos.	A
4.	Supply	Terminal to Diffuser	1" pos.	A
5.	Supply	AHU to grille	3 pos.	A
6.	Return	Inlet Grille to Terminal	2" neg.	A
7.	Return	Term to Return Air Fan	4" neg.	A
8.	Return	All AHU Return	1" neg.	A
9.	General Exhaust	Inlet to Unit	1" neg.	A
10.	Air Transfer Duct	All	2" neg.	A

Schedule Legend:

Duct Material

A Galvanized Steel

END OF SECTION 15840

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SECTION 15846  
PRE-FABRICATED DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Single Wall Round or Flat Oval Galvanized Steel Ductwork and Fittings.
- B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings.
- C. Insulated Round Flexible Ductwork.

1.3 QUALITY ASSURANCE

- A. All ductwork shall be fabricated within the guidelines established by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition.
- B. All ductwork shall be fabricated to withstand the pressure and velocity required on this project.
- C. All components, fasteners, sealants, adhesives, etc. in the conditioned air stream or exposed in active or non- active plenums shall conform to the NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems and Standard for Flame/Smoke/Fire Contribution of 25/50/0.
- D. All ductwork shall conform to UL standard UL 181 Factory Made Air Duct Materials and Duct Connectors, latest edition. Applicable sections shall apply to shop fabricated ductwork.
- E. After fabrication and installation of all shop fabricated ductwork the fabricator and installer, if not the same, shall certify in writing to the Owner's representative that all shop fabricated ductwork and installation of same meets or exceeds the quality standards established by SMACNA.

1.4 SUBMITTALS

- A. Submission for acceptance is required.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 for submittal requirements.

1.5 SHOP DRAWINGS

- A. Shop Drawings: Provide shop drawings of ductwork as follows:
  - 1. Draw to a scale of not less than 1/4 inch to one foot on the same size sheets as the contract drawings.

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- 2. Show duct sizes.
  - 3. Show fitting details.
  - 4. Show lighting and ceiling diffusers.
- B. Floor Plans: Provide sheet metal floor plans drawn to the same scale as the contract drawings.
- 1. Use contract drawing sheet size.
  - 2. Show on each floor plan the floor penetrations, fire dampers and access doors, ducts with sizes and bottom elevations, terminal types and air quantities.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Single Wall Round or Flat Oval Galvanized Steel Ductwork and Fittings:

- 1. Autoduct, Inc.
- 2. Eastern Sheet Metal
- 3. Hamlin Sheetmetal, Inc.
- 4. Impulse Air.
- 5. Lindab
- 6. Semco Manufacturing, Inc.
- 7. United McGill

B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings:

- 1. Alco Manufacturing Company.
- 2. Crown Products Company.
- 3. Hughes.

C. Insulated Round Flexible Ductwork:

- 1. ATCO Rubber Products, Inc.
- 2. Flexmaster USA, Inc.
- 3. Flexible Technologies - Thermaflex®

2.2 FABRICATION

A. Single Wall Round or Flat Oval Ductwork and Fittings:

- 1. Materials: Hot rolled, continuously annealed, hot dipped galvanized steel minimum of G-90, 0.90 oz/sf coating, conforms to ASTM A653.
- 2. Metal Gauges: Conform to the Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition. The following table shall establish a minimum guideline unless the manufacturer has U.L. Standard 181 test results that show that lighter gages (thinner wall thickness) with intermediate corrugations (ribs) allow the gage reduction:

<u>Pipe Diameter</u>	<u>Positive Internal Static Pressure in W.G.</u>			
0" - 2.0"	2.1" - 4.0"		4.1" - 10.0"	
Spiral	Spiral		Spiral	
Pipe Fittings	Pipe	Fittings	Pipe	Fittings

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6" - 10"	28	26	28	24	28	24
12"	28	26	28	24	26	24
14"	28	26	26	24	26	24
16"	26	24	26	22	24	22
18" - 26"	26	24	24	22	24	22
27" - 36"	24	22	22	20	22	20
37" - 50"	22	20	20	20	20	20
51" - 60"	20	18	18	18	18	18
61" - 84"	18	16	18	16	18	16

Major Axis Dimension Positive Internal Static Pressure in W.G.

	0" - 2.0"		2.1" - 4.0"		4.1" - 10.0"	
	Pipe	Fittings	Pipe	Fittings	Pipe	Fittings
6" - 24"	24	20	24	20	24	20
25" - 36"	22	20	22	20	22	20
37" - 48"	22	18	22	18	22	18
49" - 60"	20	18	20	18	20	18
61" - 70"	20	16	20	16	20	16
71" - Up	18	16	18	16	18	16

3. Duct Construction: Spiral wound, lockseam construction, slip joint or flanged connections as noted below under couplings.
4. Fitting Construction:
  - a. 90 Deg. and 45 Deg. Ells: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Radiused ells to be full radiused unless otherwise noted, mitered ells to have single thickness, turning vanes, slip joint or flanged connections.
  - b. Tees or Crosses: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Tangential, unless otherwise noted or detailed, conical take off or reduction, slip joint or coupled ends. 180 Deg. or 45 Deg. as indicated.
  - c. Bellmouth: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Spun metal, smooth converging bellmouth, round, gauge equal or greater than connecting duct.
  - d. Access Section:
    - 1) 7" Diameter and Less: Minimum 12" long flanged section, minimum four bolts per flange.
    - 2) 8" Diameter and Larger: Round or rectangular access cover, on welded raised section, pressure sensitive release suitable for manual release or emergency vacuum release, chain retainer, (see Para. 3.5: Schedules for Sizes).
  - e. Couplings:
    - 1) Joints 36" or less shall have 2" slip coupling.
    - 2) 38" or over shall be spiral mate or oval mate.
  - f. Based on United McGill or approved equal.



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B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings:

1. Materials: Hot rolled, continuously annealed, hot dipped galvanized steel minimum of G-90, 0.90 oz/sf coating, conforms to ASTM A653.
2. Metal Gauges: Minimum of 26 gauge, with remaining sizes conforming to the Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA) HVAC Duct Construction Standards Metal and Flexible, latest edition. The following table shall establish a minimum guideline:

Round Ducts:

<u>Duct Diameter</u>	<u>Spiral Pipe</u>	<u>Fittings and Longitudinal Seam Pipe</u>
3" thru 14"	26	24
15" thru 26"	24	22
27" thru 30"	22	20

3. Duct Construction: Snaplock seam construction, slip joint or flanged connections.
4. Fitting Construction:
  - a. 90 Deg. and 45 Deg. Ells: Adjustable ells to be full radiused unless otherwise noted, slip joint or flanged connections.
  - b. Tees or Crosses: Adjustable, unless otherwise noted or detailed, conical take off or reduction, slip joint or coupled ends. 180 Deg. or 45 Deg. as indicated.

C. Insulated Round Flexible Ductwork:

1. High Pressure Application:
  - a. Factory fabricated assembly of a trilaminate of aluminum foil, fiberglass and polyester with a perm rating of .02, high tear strength and properties to resist temperature change, mildew and age hardening. It shall be mechanically locked, without adhesives, into a formed aluminum helix on the ducts outside surface and be U.L. listed 181 Class 1 and comply with NFPA 90A and 90B. The material shall have a pressure rating of 12" w.g. positive pressure and -5" w.g. negative pressure through a temperature range of -20°F to +250°F.
  - b. The duct material shall be factory wrapped in a blanket of fiberglass insulation with a C factor of .23 or less. The insulation shall be encased in a fire retardant reinforced aluminum material vapor barrier with a perm rating of not over .05 grains per square ft. per hour per inch of mercury.
  - c. Based on Type 3M as manufactured by Flexmaster U.S.A., Inc., ATCO Rubber Products UPC #036 or Omni Air 1200, or Flexible Technologies – Thermaflex M-KF.
2. Low Pressure Application:
  - a. Factory fabricated assembly of a trilaminate of aluminum foil, fiberglass and polyester with a perm rating of .02, high tear strength and properties to resist temperature change, mildew and age hardening. It shall be mechanically locked, without adhesives, into a formed aluminum helix on the ducts outside surface. It shall be U.L. listed 181 Class 1 and comply with NFPA 90A and 90B. The material shall have a pressure

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- rating not less than 6" w.g. positive pressure and -3" w.g. negative pressure through a temperature range of -20°F to +250°F.
- b. The duct material shall be factory wrapped in a blanket of fiberglass insulation with a C factor of .23 or less. The insulation shall be encased in a fire retardant reinforced aluminum material vapor barrier with a perm rating of not over .05 grains per square ft. per hour per inch of mercury.
  - c. Based on Type 5M as manufactured by Flexmaster U.S.A., Inc., ATCO Rubber Products UPC #036 or Omni Air 1200, or Flexible Technologies – Thermaflex M-KF.
- D. Ductwork, General: Each duct section shall have both ends covered with polyethylene or other suitable material to protect against the entrance of dirt, debris or water during shipment and storage prior to installation.
- E. DUCT SEALANT: Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, used indoors or outdoors. Foster 32-19 Duct Fas, Childers CP-146 Chil Flex or Duro Dyne SAS.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

- A. Install in strict accordance with the manufacturer's written installation instructions.
- B. The drawings, due to their small scale, are diagrammatic in nature and are not necessarily complete in all details. For this reason not all necessary offsets, rises or falls are shown. Coordinate the installation of the ductwork with all other trades and to provide all necessary offsets, etc. as required for completion of this project without any additional cost to the Owner, Architect or Engineer.
- C. All ductwork shall be run parallel or perpendicular to building structure and seams or spirals shall be aligned whenever possible.
- D. All sizes indicated on the drawings are inside clear dimensions.
- E. All ductwork shall be properly sealed in a neat clean manner with all excess sealer wiped clean.
- F. Coordinate the location of, provide the necessary access and install all devices provided in other specification sections within Division 15, including but not limited to fire, smoke and/or balancing dampers, access and mounting for control devices, air flow measuring stations, etc., as apply to this project.
- G. All ducts passing through partitions or walls shall be properly and neatly sealed. If partition or wall carries a fire rating (fire damper indicated or if architectural plans indicate a rated wall) the duct shall be sleeved with the space between the sleeve and duct properly sealed with firestopping material (Refer to Section 15050 and/or Division 7 for firestopping requirements). The sleeve shall be permanently affixed to the wall (see Section 15090: Supports, Hangers, Anchors and Sleeves for sleeve specification).
- H. Coordinate the proper duct pressure classification with the system served and to provide the proper ductwork to withstand these pressures. (See Para. 3.5 Schedules: System Pressure Classification and Duct Material Schedule.)

3.2 CLEANING AND PROTECTION

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- A. During construction, ductwork shall be cleaned of dirt and debris internally section by section as it is installed. At end of each day, ductwork not finally connected to equipment shall be provided with a temporary closure of polyethylene film or other covering material that will prevent entrance of dust, debris or water. Clean exterior surfaces of any material which might cause corrosion or if the duct is to be painted, it shall be cleaned suitable for painting. After substantial completion of the ductwork system the system shall be operated with filters in place to blow-out any remaining dust from the system. Protect all equipment and property from damage or fouling during this cleaning. All prefilters used during cleaning shall be replaced prior to turning the system over to the Owner.
- B. During field investigations, if the Owner or Engineer inspect ductwork and find dust, debris, water or any other contaminant the contractor will be responsible for cleaning or replacing, at the discretion of the Owner and Engineer, the ductwork section at the contractor's expense.

3.3 LEAK TESTING

- A. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater) operationally air-tight, with no more than 2% leakage for duct systems rated at 2" w.c. pressure class, and 1% leakage for systems exceeding 2" w.c. pressure class. Leakage test to be performed by Contractor with all air device openings and fan connections sealed airtight. Test the systems prior to applying any insulation or concealing in soffits or chases. Use a portable fan capable of producing a static pressure equal or greater than the duct test pressure. This fan to have a flow measuring assembly consisting of a straight section of duct with an orifice plate, pressure taps, and a calibrated performance curve for determining leakage rates.
  - 1. Test each section equal to the external static pressure indicated for that fan or air handler with the portable fan assembly. After the fan achieves that steady state design pressure, record the air flow quantity across the orifice and the percent of design air flow. If the test fails, the Contractor shall reseal and retest at no additional cost to the Owner.
  - 2. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.
  - 3. Submit duct leakage reports to the Balancer and the Engineer for their review and approval.
  - 4. Refer to specification section 15051 for more information.

3.4 INSTALLATION

- A. General:
  - 1. Install generally as indicated.
  - 2. Conceal ductwork in finished spaces unless indicated otherwise.
  - 3. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine room, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms or spaces.
  - 4. Exercise special care to provide tight fitting well fabricated, well braced ductwork systems.
  - 5. Field assemble rectangular, round or flat oval ductwork as follows:

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- a. Use slip joints, couplings, etc. sealed with adhesive pre-applied to couplings or duct mate spiralmate or oval mate on duct sizes 1" and larger.
  - b. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets and gaskets and washers for bolts.
- 6. In high pressure ductwork (above 2" w.g.), do not use 2 piece mitered 90 degree elbows with or without vanes unless approved by engineer.
  - 7. Make duct connections from hoods, openings, fans and other devices.

B. Insulated Round Flexible Ductwork:

- 1. Provide where indicated or required on supply air ducts.
- 2. Coordinate the insulation requirements as to assure a continuous and consistent thermal resistance and vapor barrier.
- 3. Maximum length shall be 5'-0".
- 4. Maximum turn or bend shall be no more than 90 Deg. Provide rigid elbows where 90 Deg. turns are indicated on the drawings or more than one 90 Deg. turn is required.
- 5. Flexible ductwork shall be cut to the proper length. Coiling or unnecessary offsets will not be permitted.
- 6. Provide Stainless steel draw band to seal inner liner tight to connecting duct. Pull insulation over inner liner and fold vapor barrier over end of insulation. Secure with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth.
- 7. High pressure flexible duct to be provided upstream of all terminal boxes. Low pressure flexible duct may be used downstream of terminal box.
- 8. Rigid round ductwork may be substituted in lieu of flex unless the flex duct is used for vibration isolation or otherwise detailed. If omitted, external insulation must be provided per Section 15250 - Insulation.

3.5 SCHEDULES

A. System Pressure Classification and Duct Material Schedule:

System I.D. #	System	Section	Maximum Pressure	Duct Material
1.	Supply	AHU to Terminal	3" pos.	A
2.	Supply	Terminal to Diffuser	1" pos.	A
3.	Return	Terminal to AHU	2" neg.	A

Schedule Legend:

Duct Material

A Galvanized Steel

B. Access Door Schedule:

1. Round Duct:

	<u>Duct Size</u>	<u>Access Door Size</u>
a.	up to 7" dia.	12" long removable section
b.	8" to 12" dia.	8" x 12"

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- |    |                 |           |
|----|-----------------|-----------|
| c. | 13" to 18" dia. | 12" x 12" |
| d. | 19" dia. and up | 14" x 20" |

2. Flat Oval Duct

	<u>Duct Size</u>		
	<u>Major Axis</u>	<u>Minor Access</u>	<u>Access Door Size</u>
a.	8" to 16"	8" to 11"	8" x 12"
b.	17" to 24"	12" to 13"	12" x 12"
c.	25" and up	14" and up	14" x 20"

END OF SECTION 15846

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SECTION 15860  
SHEET METAL SPECIALTIES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

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

1.2 WORK INCLUDED

- A. Duct access doors.
- B. Volume dampers.
- C. Fire dampers.
- D. Flexible duct connectors.
- E. Install miscellaneous control devices.

1.3 QUALITY ASSURANCE

- A. All products provided for enhancement of Life Safety shall be UL listed and bear the appropriate label stating compliance.
- B. All products located in the conditioned air stream or located in return air plenums shall conform to the NFPA 90A Flame/Smoke/Fuel Contribution of 25/50/0 and all other applicable requirements of NFPA 90A.
- C. Provide Florida Product Approval Numbers for all Products required by the Florida Building Code (FAC 9N-3).

1.4 SUBMITTALS

- A. Submission for acceptance is required.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Duct Access Doors:
  - 1. Air Balance, Inc.
  - 2. Cesco Products
  - 3. Greenheck, Inc.
  - 4. Nailor Industries, Inc.
  - 5. Prefco Products, Inc.
  - 6. Ruskin Manufacturing, Co.

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7. Pottorff

B. Fire Dampers:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck, Inc.
4. Nailor Industries, Inc.
5. Prefco Products, Inc.
6. Ruskin Manufacturing, Co.
7. Pottorff

C. Volume Dampers:

1. Air Balance, Inc.
2. Arrow United Industries, Inc.
3. Cesco Products
4. Greenheck, Inc.
5. Nailor Industries, Inc.
6. Prefco Products, Inc.
7. Ruskin Manufacturing, Co.
8. Pottorff

D. Flexible Duct Connectors:

1. Ductmate Industries, Inc.
2. Duro-Dyne
3. Elgen
4. Ventfabric

2.2 FABRICATION

A. Duct Access Doors:

1. Low Pressure Ductwork:

- a. Rating up to 2" wg positive or negative.
- b. Frame: Minimum 22 gauge galvanized steel or aluminum, minimum 5/8" knock over edge, neoprene gasket between frame and duct and frame and door.
- c. Door: Minimum 24 gauge galvanized steel or aluminum, continuous hinge and cam latches or minimum 2 cam latches, double wall construction, fiberglass insulated thickness to match ductwork.
- d. Based on Ruskin Manufacturing Co. ADH24 or approved equal.

2. High Pressure Ductwork:

- a. Rating: Up to 10" wg positive pressure.
- b. Frame: Minimum 16 gauge galvanized steel with "Z" shaped reinforced corners, polyurethane gasket between frame and duct and frame and door.
- c. Door: Minimum 16 gauge galvanized steel or aluminum, minimum 2 spring latches, double wall construction, fiberglass insulated with thickness to match ductwork.
- d. Based on Ruskin Manufacturing Co. ADHP-3 or approved equal.

B. Fire Dampers:

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1. Rating: 1-1/2 hours (UL approved for installation in 2 hour walls).
2. Construction: Minimum 24 gauge galvanized steel frame suitable for connection to ductwork without transition, minimum 24 gauge galvanized steel curtain type blades located out of the airstream, thickness coordinated with wall construction. Where an active smoke control system exists (refer to section 15950) the damper shall be capable of closing in an airstream moving at a minimum of 2000 feet per minute and operating at 4" w.g. pressure (dynamic damper).
3. Sleeves: UL listed minimum gauge galvanized steel with welded construction corners. Rollformed sleeves will not be acceptable unless contractor guarantees in writing to seal voids in sleeve with UL approved sealer to limit air leakage. Length of sleeve shall be coordinated with the wall or floor.
4. Operation: Stainless steel constant force closure spring.
5. Link Setting: 160 or 165°F.
6. Based on Ruskin Manufacturing Co. IBD2 Style B. (Static Systems) or approved equal.  
Based on Ruskin Manufacturing Co., DIBD2 Style B. (Active smoke control systems only) or approved equal.

C. Volume Dampers:

1. Provide volume dampers where indicated and construct as follows:
  - a. Provide single blades to a maximum of 10 inch blade width.
  - b. Provide inside end synthetic bearings and locking quadrants with wing nuts.
  - c. Friction locks are not permitted.
  - d. Break damper blades on both edges for stiffness.
  - e. Provide multi-blades on dampers 12 inches and larger with inside pins and molded synthetic bearings, and 2 inches wide by 1/8 inch thick structural galvanized channel frame.
  - f. Provide galvanized connecting bar with molded synthetic bearings on multi-blade dampers.
  - g. Provide stand off bracket for installation in externally insulated duct.
  - h. Based on Ruskin Manufacturing, Co. MD35 for rectangular ducts (MDSR25 for round ducts) with velocities up to 1500 feet per minute or approved equal.
  - i. Based on Ruskin Manufacturing, Co. CD30AF1 for rectangular ducts (CDR82 for round ducts) with velocities over 1501 feet per minute or approved equal.

D. Flexible Duct Connectors:

1. Indoor Applications:
  - a. Material: Heavy glass fabric double - Coated with neoprene, Minimum of 30 oz/sy, Resistant to abrasion and damage due to repeated flexing, waterproof and air tight, minimum 26 gauge galvanized steel or .032" aluminum edge a minimum of 2-1/2" wide each side, coordinate flex width with schedule in 3.3: Schedules.
  - b. Rating:
    - (1) Temperature: -10°F to 200°F
    - (2) Pressure: 10" positive  
10" negative
    - (3) Based on Ventfabric and Ventglass or approved equal.



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PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install all products in strict accordance with the manufacturer's written installation instructions.
- B. Coordinate the installation of products provided within other sections of Division 15 including but not limited to control dampers, air flow measuring stations, etc.

3.2 INSTALLATION

A. Duct Access Doors:

- 1. Coordinate the proper class access door with the system requirements.
- 2. Duct access doors shall be mounted so as to allow maximum access and/or door swing while also providing easy access from the floor or other personal accessible structures.
- 3. Duct access doors shall be provided wherever required for proper maintenance of equipment, access to duct mounted control devices, or visual inspection and setting of dampers, etc. All doors, due to the small scale of the drawings, may not be shown, it is the contractor's responsibility to coordinate with all trades concerned to provide the necessary quantity and properly locate all doors.

B. Fire Dampers:

- 1. Fire dampers shall be provided where indicated.
- 2. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
- 3. All fire dampers shall be mounted within a UL approved thickness galvanized steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
- 4. The fire damper shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly sealed with fire barrier material. (See Section 15050: Basic Materials and Methods for Fire Barrier Material.)
- 5. Ductwork shall be attached to the fire damper by means of a UL approved break away connection.
- 6. Access doors or access sections shall be provided at all fire damper locations.

C. Volume Dampers: Install at branch take-offs.

- 1. Install a 24" long yellow strip of material to each damper handle for easy visual location. These strips must be in place prior to Substantial acceptance.

D. Flexible Duct Connectors:

- 1. Flexible duct connectors shall be omitted where air handling units are provided with internally isolated fans and internal isolation.
- 2. Provide flexible duct connectors immediately adjacent to all in-line or ductwork connected fans and/or fan equipped units without internal vibration isolation.
- 3. Flexible duct connectors shall be properly selected and installed to ensure against collapsing under negative pressure and unacceptable ballooning under positive pressure. Leakage is not permissible. See width schedule in 3.3: Schedules.

E. Install Miscellaneous Control Devices: Install duct smoke detectors provided under Division 16.

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3.3 SCHEDULES

A. Access Door Schedule:

1. Square or Rectangular Duct work:

Access Door Mounting

	<u>Surface Max. Dim.</u>	<u>Access Door Size</u>
1.	6"	12" long Remov. Section
2.	7" to 8"	6" x 6"
3.	9" to 12"	8" x 8"
4.	13" to 18"	12" x 12"
5.	19" and up	16" x 16"
6.	Special Situations	See Plans

B. Flexible Duct Connector Schedule

1. Indoor and Outdoor Material Width Schedule

	<u>Duct Size</u> <u>(Max. Dim.)</u>	<u>Pressure</u> <u>(Max.)</u>	<u>Width</u>
a.	12" and less	positive	3"
b.	13" and up	positive	6"
c.	12" and less	negative	3"
d.	13" and up	negative	3"

END OF SECTION 15860

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SECTION 15880  
FILTERS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 WORK INCLUDED

- A. Extended Surface, Pleated, Panel Type Pre Filters.

1.3 QUALITY ASSURANCE

- A. Filter testing to be in accordance with UL Standard 900.

1.4 SUBMITTALS

- A. Submission for acceptance is not required.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Refer to Division 1 requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Extended Surface, Pleated, Panel Type Pre Filters.
  - 1. Airguard.
  - 2. American Air Filters.
  - 3. Camfil-Farr (30/30)
  - 4. Farr.
  - 5. Flanders Filters, Inc. (Pre-Pleat HV)
  - 6. Glasfloss Industries, Inc.
  - 7. Purolator Products Air Filtrtion Co.
  - 8. Tri-Dim Filter Corporation.

2.2 FABRICATION

- A. Extended Surface, Pleated, Panel Type Pre Filters:
  - 1. Extended surface pleated, cotton/synthetic fiber media, cardboard frame, wire support grid, dry type.
  - 2. Dry filtering principal.
  - 3. 2" thick, 25% average efficiency, UL Class 2 approved, maximum face velocity 500 FPM.
  - 4. Initial maximum air friction at 500 FPM equals .30. Air friction at change-out equals 1.00" w.g.
  - 5. Based on AAF AM-Air 300 or approved equal.

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PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install filters in strict accordance with manufacturers recommendations.
- B. Particular attention to prevent air bypass through filter support system.
- C. Do not operate fan systems without final and pre-filters in place.
- D. Provide one extra set of pre-filters.

END OF SECTION 15880

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SECTION 15891  
MECHANICAL CLEANING OF DUCTWORK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 SCOPE OF THE WORK

- A. Provide all labor, materials, facilities, equipment and services to thoroughly clean ductwork systems located within the Maxey Community Center.
  - 1. The Contractor will provide the estimated dates from start to finish to perform the cleaning services.
- B. The cleaning work for each building is to include but not limited to the following components:
  - 1. All supply and return ductwork, lined and unlined, including ductwork plenums, branches, risers, etc.
  - 2. Exhaust duct system.
  - 3. Exhaust fan.
  - 4. Fire and fire/smoke dampers.
- C. Contractor will provide all labor, material and services to obtain access to associated components including:
  - 1. Removal of ceiling tiles.
  - 2. Installation of new access panels and removal/replacement of existing panels.
  - 3. See Section 3.9 for specification on reinstallation of removed materials.
- D. The bidders are encouraged to attend the pre-bid, site visit conference prior to submission of a bid proposal, to compare site conditions with drawings and/or specifications and to satisfy themselves of conditions existing at the site and all other matters that may be incidental to the work performed under this contract. No allowance will be made to the successful contractor by reason of any error on his/her part due to neglect to comply with the requirements of this paragraph. No extra charge will be allowed for work caused by unfamiliarity with the work area.
- E. It is the responsibility of the Contractor to verify field conditions before start of work.
- F. The Contractor will repair and replace to match existing materials where access to walls or ceilings was made, or damage occurs, including but are not limited to:
  - 1. Ductwork and components.
  - 2. Insulation.
  - 3. Others as applicable.
- G. Scope of the work also includes the following:
  - 1. The Contractor, on the basis of field inspections and review, must determine the method of cleaning the HVAC systems and its component to prevent any damage to the system and its operation. Upon completion of the initial

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inspection, the Contractor will notify the Project Engineer of the proposed methods and their effects to the system.

2. Reset all balancing dampers to original settings if moved during work. Be sure to mark original position so that during the final inspection, original settings can be field verified.
3. Report to Project Engineer any system defects discovered during the cleaning operation, which will require repair to an HVAC system (e.g. equipment, ductwork, dampers, registers, etc.).

### 1.3 QUALITY ASSURANCE

A. Ductwork shall be cleaned in compliance with latest edition of the following standards:

1. Mechanical cleaning of non-porous air conveyance system components, NADCA 1992-01.
2. Debris levels shall conform to:

Surface Debris Weight	< 100MG/100cm <sup>3</sup>
Total Surface Bacteria	< 30,000 cfu/g
Total Surface Mold	< 15,000 cfu/g

Note: cfu/g refers to colony forming units per gram of debris.

3. Plans and specifications which exceed the requirements in any of the referenced standards.

B. All sheetmetal shall be fabricated and installed by an experienced Contractor specializing in this type of work and approved by the Engineer.

### 1.4 SUBMITTALS TO THE ENGINEER

- A. Shop drawings locating all proposed duct penetrations and ceiling access holes in plaster ceilings.
- B. Provide MSDS sheets on all solvents, cleaners and disinfectants to be used on the project.
- C. Provide submittals on any equipment or materials replacing the existing during the remediation process, i.e., diffusers, flex duct, fire dampers.

## PART 2 - PRODUCTS

### 2.1 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA Duct Construction Standards.
- B. Review locations with the Project Engineer prior to installation.
- C. Fabricate rigid and close-fitting doors or galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch (25 mm) thick insulation sheet metal cover. All materials to be approved prior to use.
- D. Access doors smaller than 12 inches may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches (450 mm) square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x

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49 inches (600 x 1200 mm). Provide an additional hinge for large sized.

- F. Access doors with sheet metal screw fasteners are not acceptable.
- G. All doors must be leak tight at the completion of the job.
- H. Doors shall be similar to Ventlock insulated access door, or Ruskin Model #CAD.

2.2 DUCT DISINFECTANT

- A. Equal to Madacide, as supplied by Mateson Chemical, EnviroCon as manufactured by Bio-Cide International, Inc., or approved equal.

2.3 SANITIZER

- A. An E.P.A. registered sanitizer "Oxine" as manufactured by Bio-Cide International or approved equal. Product shall be a mixture of Oxychloride compounds.

2.4 ENCAPSULANT

- A. A duct liner adhesive coating, Foster 40-10 or 40-23, as manufactured by Foster Products Corporation, or approved equal. It shall be a quick setting waterbase adhesive and coating designed for field application to faced or unfaced fiberglass duct liner insulation, or to unfaced fiberboard ductboard insulation. The coating shall dry to form an effective air erosion preventive coating, sealing and reinforcing the surface. The coating shall be resistant to fire, water, oil, grease, bacteria and fungus.

2.5 PLENUM PLANT

- A. Porous Surface: The paint shall be Porta-Sept as manufactured by Porter Plains, Inc. or approved equal. Paint shall contain an EPA registered anti-microbial, Intersept, which inhibits the growth of bacteria, mold, mildew and fungi.
- B. Non-Porous Surface: The coating shall be Tough-Coat as manufactured by Vac Systems Industries or approved equal. Coating shall meet NFPA Standards 90A and 90B, and contain an anti-microbial agent.

2.6 DUCT LINING

- A. To match existing.

2.7 GASKETING

- A. To match existing.

PART 3 - EXECUTION

3.1 PRE-CLEANING PREPARATIONS

- A. Prior to start of work, the HVAC system is to be carefully inspected and checked for all conditions affecting the cleaning. Defects are to be reported in writing to the Project Engineer, and work will not precede until defects have been documented. Commencement of work will constitute acceptance of the conditions of the area to which the cleaning work is to be performed, and all defects in work resulting from such accepted service will be corrected by this trade without additional expense to the Owner.

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No cleaning is to be performed to ducts where the process has the capability of damaging the duct lining. This decision will be made by the Project Engineer after review of the Contractor's findings, and the Project Engineer has seen the field conditions.

- B. Disassemble all removable items as required for access to work area. Store the removables in a Project Engineer approved storage area until the completion of the cleaning work.
- C. Fire protection devices (such as smoke detectors, panel, etc.) shall be protected prior to cleaning procedures. They are to be cleaned and tested at the conclusion of the work.
- D. The Contractor shall coordinate the shutdown and reactivating of the fire alarm system to avoid accidental alarms during cleaning process and related work.
- E. The Contractor shall coordinate the shutdown of the air handling equipment with the Owner before starting work, and shall conform to the OSHA requirements regarding fan motor disconnect lock-outs.
- F. The Contractor shall have samples collected by gathering the gross debris from the surface of the duct at a minimum of three (3) locations per system prior to and after cleaning. This shall be accomplished by utilizing protective clean surgical gloves to handle the surface debris. A 100 cm<sup>2</sup> area shall be scraped, and the debris placed in a 4 oz. sterile container with a screw cap. The container shall be adequately marked as to sample location, date and time as a minimum. The total weight will be established per 100 cm<sup>2</sup> of surface area. The quantity of viable microorganisms will be determined by culture methods. Data will be presented as Colony Forming Units (cfu's) per gram and will be compiled for both bacteria and mold/fungi. Samples and tests will be performed by an independent third party testing Contractor. The Contractor and Project Engineer shall conduct inspections to insure that the samples are retrieved at locations that are representative of the ductwork.

### 3.2 CLEANING PROCEDURES

- A. Sequence of work on each air handling system:
  - 1. Review area with the Project Engineer.
  - 2. Determine locations of ductwork, ventilation needs, sensitive equipment protection requirements, access and cleaning procedures.
  - 3. Notify Maintenance Staff to shut down the air handling system(s).

### 3.3 CLEANING AND REMOVAL METHOD

- A. The following general ductwork cleaning procedures are to be used as a guideline throughout the project. Determination of which method should be used in each area is to be made by the Contractor and the Project Engineer. Contractors are to provide detailed procedures in their bid proposal. Deviations from specified methods of removal must be approved by the Project Engineer prior to their implementation.
- B. Methods:
  - 1. Debris Collection Equipment:
    - a. Equipment used shall be portable and sized to enter the areas easily. Electrical requirements shall be the responsibility of the Contractor, and any cost incurred due to modifications to the electrical systems shall be at the Contractor's expense.



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- b. The collection systems shall be self-contained units, with the appropriate components to adequately collect dirt and debris loosened from the ductwork. Air duct cleaning is to be performed by a high powered vacuum system with three stages of filtration. The final stage shall be HEPA filter. HEPA efficiency shall be 99.97 @ 0.3 micron.
  - c. The collection system shall be capable of producing a minimum of .42" water gauge negative static pressure in the area of ductwork to be cleaned.
2. Agitation Equipment:
- a. Air power cleaning of all interior ductwork, fan housings and HVAC units performed by a high pressure compressed air system which will be directed through small access doors in the ductwork. All access doors are to be provided per Section 2.1.
  - b. Compressed air powered Gollum technology generating 90 CFM at 110 psi, as means of dislodging the debris shall be used. Air powered lances, extended whip sections, or oscillating brush systems may also be used.
  - c. Electric robotic air powered brushing systems, or electric rotary brush systems may be used.
  - d. Cleaning tools such as skipper balls, or air sweeps may not be used due to their inability to contact clean all sides of the duct.
  - e. Where ductwork is large enough and able to support the weight of a worker, hand tools and vacuums may be used. If workers enter the inside of the duct, they must follow the OSHA confined space requirements (OSHA 29 CFR 1910.146).
- C. Open Ductwork: During the cleaning process, provide temporary closures of metal or taped polyethylene on open ductwork to prevent the dust during the cleaning process from dispersing throughout the work area.
- D. All lined ductwork is to be encapsulated as applicable.
- E. Controlling Odors: All responsible measures shall be taken to control any and all offensive odors and/or mist vapors generated during the cleaning process.
- F. Containment: Debris removed during the cleaning process shall be collected and tagged as to its origin within the Air Conveyance System (ACS). Precautions must be taken to ensure that debris is not dispersed outside the ACS during the cleaning process.

3.4 CLEANING OF HVAC COMPONENTS

- A. Ceiling Plenums and Mechanical Rooms: All loose debris shall be removed, and the entire ceiling plenum or mechanical room including, but not limited to, duct exterior, walls, deck, top of ceiling tiles, structural steel, piping, conduit, light fixtures shall be mechanically vacuumed. The plenum or Mechanical Room shall be visibly clean, but will not be subject to verification as per NADCA Standards.
- B. Volume, Fire and Zone Dampers: Duct mounted volume, fire and zone damper sets are to be marked to their current setting, then inspected and cleaned if necessary. External moving parts are to be treated with an approved dry lubricant material. After cleaning, the dampers shall be repaired as necessary to insure proper operation and returned to original settings. Contractor shall indicate locations of damaged and/or repaired dampers.

### 3.5 FINAL INSPECTION

- A. A final check is to be carried out to ensure that no dust or debris remain on surfaces as the result of dismantling operations.
- B. The Project Engineer will thoroughly inspect the place jointly with the Contractor, to determine whether any damage has been done on the finishes, equipment or any other part of the work place. A final inspection report will be prepared jointly between the Project Engineer and the Contractor detailing the list of items to be fixed by the Contractor.

### 3.6 VERIFICATION

- A. General verification of cleanliness will be determined after Mechanical Cleaning and before the application of any treatment or introduction of any treatment-related substance. Verification of Non-Porous Surface cleaning and shall be conducted after Mechanical Cleaning and before the system is restored to normal operation.
- B. Verification of Non-Porous Surface Cleaning:
  - 1. All Non-Porous Interior Duct surfaces must be visibly clean and capable of passing the NADCA Vacuum Test.
  - 2. The weight of debris collected by the NADCA Vacuum Test, as outlined in Appendix A of the NADCA Standards, shall not exceed 1.0 mg/cm<sup>2</sup>.
  - 3. The Contractor shall include in the bid, the cost for four independent vacuum tests to be performed at the time and location as directed by the Engineer. If any areas fail, the failed area shall be recleaned and retested at no cost to the Owner.
  - 4. Debris shall conform to the following:

Surface Debris Weight	< 100mg/100cm <sup>2</sup>
Total Surface Bacteria	< 30,000 cfu/g
Total Surface Mold	< 15,000 cfu/g

Note: Cfu/g refers to colony forming units per gram of debris.

### 3.7 SEQUENCE OF WORK

- A. Since the systems must be operational during the normal work hours, the Contractor shall submit to the Owner a procedure and schedule for cleaning the ductwork and installing filters which will minimize contamination of already cleaned areas. This schedule must be approved by the Owner prior to starting work.

### 3.8 SANITATION

- A. A sanitizer shall be applied to all supply and return air metal only ductwork cleaned as part of this project. Application shall be as per manufacturer's recommendation.

### 3.9 RESTORATION, REPAIRS AND INSTALLATION

- A. Repair and restore space in accordance with the final inspection list specified herein. If no additional modification of the work space is to take place, re-install all removable equipment and fixtures back in the space.

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- B. Any damages to the finishes, floor, walls or any other item or fixture that has been the result of actions by the Contractor personnel is to be repaired to their original condition without any additional costs.
- C. Reinstall existing and install new accessories in accordance with manufacturer's instructions.
- D. Demonstrate resetting of fire and balancing dampers to authorities having jurisdiction and Owner's representative.
- E. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers at fire dampers, and elsewhere if required. Provide suitable size access doors for hand access or shoulder access where necessary.
- F. Reconnect mixing box to ducts. Replace flexible ducts, clamps and gasketing if damaged during removal.
- G. Reconnect diffusers to ducts, replace straps or clamps and flexible duct if damaged during removal.
- H. Repair or replace duct insulation damaged during the work. Materials to match existing.
- I. The Contractor shall replace existing prefilters and filters with new filters for each system as required.

END OF SECTION 15891

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SECTION 15900  
BUILDING AUTOMATION SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. All work of this Division shall be coordinated and provided by the single Building Automation System (BAS) Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- D. All work of this Division shall be coordinated and provided by the single Building Automation System (BAS) Contractor.
- E. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.
- F. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- G. If the BAS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.
- H. Refer to attached requirements from the Orange County Information Systems and Services (ISS) division for all Orange County hardware, software, and network requirements.
- I. The existing Building Automation System (BAS) serving the Maxey Community Center is by Johnson Controls, Inc., which was installed in 2011. The design intent is to reuse existing panels and wiring wherever possible and add additional panels as necessary. The purpose of the attached specification is for any new devices or wiring required facilitating the work shown within the Construction Documents.

1.2 BAS Description

- A. The Building Automation System (BAS) shall be an extension of the existing system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BAS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BAS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- C. The work of the single BAS Contractor shall be as defined individually and collectively in all Sections of these Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

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- D. The BAS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BAS.
- E. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- F. Manage and coordinate the BAS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- G. The BAS as provided shall incorporate, at minimum, the following integrated features, functions and services:
  - 1. Operator information, alarm management and control functions.
  - 2. Enterprise-level information and control access.
  - 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
  - 4. Diagnostic monitoring and reporting of BAS functions.
  - 5. Offsite monitoring and management access.
  - 6. Energy management
  - 7. Standard applications for terminal HVAC systems.
- H. Existing Manufacturer
  - 1. Johnson Controls

1.3 Quality Assurance

- A. General
  - 1. The Building Automation System Contractor shall be the primary manufacturer-owned branch office or primary installer of said manufacturer that is regularly engaged in the engineering, programming, installation and service of total integrated Building Automation Systems.
  - 2. The BAS Contractor shall be a recognized national installer and service provider of BAS.
  - 3. The BAS Contractor shall have a branch facility within a 50-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. Maximum response time shall be 3 hours.
  - 4. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BAS business for at least the last six (6) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.
  - 5. The Building Automation System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Automation

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Systems, and shall be the manufacturer's latest standard of design at the time of bid.

6. Single source responsibility of supplier shall be the complete installation and proper operation of the BAS and control system and shall include debugging and proper calibration of each component in the entire system both existing and new.
7. The Building Automation System contractor shall provide the Owner with 24 months of future software system upgrades as part of their package. The upgrade period shall begin once the final completion has been signed off by the engineer of record for each project.

B. Workplace Safety And Hazardous Materials

1. Provide a safety program in compliance with the Contract Documents.
2. The BAS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
3. The Contractor and its employees and subtrades shall comply with federal, state and local safety regulations.
4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.
5. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.
9. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Quality Management Program

1. Designate a competent and experienced employee to provide BAS Project Management. The designated Project Manger shall be empowered to make technical, scheduling and related decisions on behalf of the BAS Contractor. At a minimum, the Project Manager shall:
  - Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
  - Manage the financial aspects of the BAS Contract.

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- Coordinate as necessary with other trades.
- Be responsible for the work and actions of the BAS workforce on site.

1.4 Work By Others

A) The demarcation of work and responsibilities between the BAS Contractor and other related trades shall be as outlined in the BAS RESPONSIBILITY MATRIX

BAS RESPONSIBILITY MATRIX				
WORK	FURNISH	INSTALL	Low Volt. WIRING/TUBE	LINE POWER
BAS low voltage and communication wiring	BAS	BAS	BAS	N/A
BAS conduits and raceway	BAS	BAS	BAS	BAS
Automatic dampers	BAS	15	N/A	N/A
BAS Current Switches.	BAS	BAS	BAS	N/A
BAS Control Relays	BAS	BAS	BAS	N/A
All BAS Nodes, equipment, housings, enclosures and panels.	BAS	BAS	BAS	BAS
Smoke Detectors	16	16	16	16
Fire/Smoke Dampers	15	15	16	16
Fire Dampers	15	15	N/A	N/A
Fire Alarm shutdown relay interlock wiring	16	16	16	16
Fire Alarm smoke control relay interlock wiring	16	16	BAS	16
Starters, HOA switches	16	16	N/A	16
Control damper actuators	BAS	BAS	BAS	16

1.5 Submittals

A. Shop Drawings, Product Data, and Samples

1. The BAS contractor shall submit its qualifications to the Orange County's Representative after bidding has been completed but prior to the submittal of shop drawings. These qualifications shall be submitted within 15 days of contract award.
2. Once the BAS contractor receives approval from the Owner for their qualifications, the BAS contractor shall submit a list of all shop drawings with submittals dates within 45 days of contract award.
3. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
4. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BAS work.
5. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BAS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
6. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
7. The BAS Contractor shall correct any errors or omissions noted in the first review.

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8. At a minimum, submit the following:
  - a. BAS network architecture diagrams including all nodes and interconnections.
  - a. Systems schematics, sequences and flow diagrams.
  - b. Points schedule for each point in the BAS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
  - c. Samples of Graphic Display screen types and associated menus.
  - d. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
  - e. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
  - f. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
  - g. Details of all BAS interfaces and connections to the work of other trades.
  - h. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.8 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BAS provided:
  - a. Table of contents.
  - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings on the latest version of AUTOCADD shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
  - c. Manufacturers product data sheets or catalog pages for all products including software.
  - d. System Operator's manuals.
  - e. Archive copy of all site-specific databases and sequences.
  - f. BAS network diagrams.
  - g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.9 Warranty

A. Standard Material and Labor Warranty:

1. Provide a two-year labor and material warranty on the BAS.
2. If within twenty-four (24) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the cost of the BAS Contractor.



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3. Maintain an adequate supply of materials within 50 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BAS Contractor's normal business hours.

2. PART 2 – PRODUCTS

2.1 Network Area Controllers (NAC)

- A. The Network Area Controller (NAC) shall provide a thin-client, Graphical User Interface (GUI) to the Building Automation System (BAS).
  1. Local Access. The NAC shall be installed upon the owner's Local Area Network (LAN) and shall support local operator access using standard web browsers including at a minimum Microsoft Internet Explorer 8.
  2. Remote Access. A high-speed connection from the NAC to the Wide Area Network (WAN) shall be provided and maintained by the owner to facilitate remote operator access to the BAS using the standard web browsers including at a minimum Microsoft Internet Explorer 8.
- B. The NAC(s) shall meet or exceed the requirements of a BACnet<sup>®</sup> Operator Workstation (B-OWS) and a BACnet<sup>®</sup> Building Controller (B-BC).
- C. The NAC(s) shall not require any hardware, software or firmware licensing agreements.
- D. The NAC(s) shall support the following hardware characteristics as a minimum:
  1. One ( 1 ) ISO-8802.3 Ethernet Port – 10/100 Mbps
  2. One EIA-232 Port – 115.2 Kbps maximum
  3. Two EIA-485 Ports – 76.8 Kbps maximum
  4. Local onboard and/or expandable hardware inputs/outputs (I/O)
    - a. Expandable to a minimum of 96 Inputs and 64 Outputs
  5. 8 MB operating RAM
  6. 1 MB non-volatile RAM
  7. 128 MB Flash EEPROM
- E. The NAC(s) shall support the following communication protocols at a minimum:
  1. ASHRAE 135-2008 BACnet<sup>®</sup>
    - a. Point-to-Point (PTP)
    - b. Master Slave/Token Passing (MS/TP)
    - c. Ethernet
    - d. BACnet<sup>®</sup> IP (B/IP)

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2. Modbus
  - a. RTU (master or slave)
  - b. TCP (master or slave)
3. Simple Mail Transfer Protocol (SMTP)
4. Simple Network Management Protocol (SNMP)
5. Hyper Text Transfer Protocol (HTTP)
6. Short Message Service (SMS) – for GSM / GPRS modems
- F. The NAC database and all necessary Graphical User Interface (GUI) resources including animations are to be stored on the NAC. Web-enabled applications that require system graphics to be stored on the client machines will not be acceptable.
- G. The NAC shall support unlimited access by five (5) simultaneous clients
- H. Multiple NAC devices shall be capable of being installed on the same BACnet<sup>®</sup> internetwork without any separate server applications, separate network management or additional licensing.
  1. Browser clients shall have the ability to access any NAC on the internetwork directly
- I. The NAC shall provide native BACnet<sup>®</sup> communications directly with all BACnet<sup>®</sup> devices on the BACnet<sup>®</sup> internetwork. Applications that require translation of data, gateways, or mapping of any kind shall not be acceptable.
  1. The NAC shall provide BACnet<sup>®</sup> client and server functionality on all data links without any additional modules or licensing
- J. Real-time values displayed on the web browser shall update automatically without requiring a manual “refresh” of the web page.
- K. HTML programming shall not be required to create or display system graphics or data on a web page.
- L. A new point displayed on a B-OWS graphic screen shall appear automatically on the identical graphic screen served by the NAC with no further programming or file transfer required.
- M. The NAC shall be capable of automatically uploading any changes to existing GUI images or animations.
- N. The NAC shall support operator interface via the web browser the following at a minimum:
  1. Password Protection
    - a. Multiple-level password access protection shall be provided.
    - b. Passwords may be exactly the same for all software applications

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provided to communicate with the internetwork including the web-based browser interface. Passwords and access credentials shall be able to be imported from the B-OWS to the NAC.

- c. A minimum of three (3) levels of access shall be supported with a configurable matrix of operator actions allowed for each access level, broken down into at least 20 possible operator actions
- d. A minimum of 128 passwords shall be supported at each NAC
- e. Operators will be able to perform only those commands available for their respective passwords.
- f. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving an NAC browser interface in an unsupervised logged-in state.
- g. The NAC shall be configurable to provide read-only access without requiring log-on
- h. Unencrypted passwords shall not be transmitted between the NAC and the client browser

2. Alarming and Event Notification

- a. NAC shall be capable of generating configurable automatic and dynamic alarm notification that is presented on-top of any current browsing screens in the form of a pop-up message
- b. NAC shall be capable of e-mail and telephonic test message notification of system alarms configurable to include notification class, recipient, inclusive and exclusive times and days as well as transition states (to alarm, to fault, return to normal). Systems that use e-mail and/or text message as the exclusive means of annunciating alarms are not acceptable.
- c. System shall provide log of notification messages.
- d. Alarm messages shall be in user-definable text and shall be entered either at the B-OWS terminal or via remote communication
- e. An alarm summary shall be available to show all alarms including but not limited to whether or not they have been acknowledged
- f. System shall provide ability to prioritize and differentiate communications for at least 255 different levels of alarms
- g. Alarm messages shall be fully customizable in size, content, behavior and sound.

3. Weekly, Annual and Special Event Exception Scheduling

- a. Provide ability to view and modify the schedule for the calendar week and up to 255 special events in a graphical format. Each calendar day and special event shall provide at least six time/value entries per day.

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- b. Provide the ability for the operator to select scheduling for binary, analog, or multi-state object values.
  - c. Provide the ability for the operator to designate days, date ranges, or repeating date patterns as exception schedules.
  - d. Provide the capability for the operator to define special or holiday schedules and to link the BACnet schedule to a BACnet calendar, thereby over-riding weekly schedule programming on holidays defined in the BACnet calendar.
  - e. There shall be a provision with proper password access to manually override each schedule.
  - f. Provide the capability to designate any exception schedule to be “Executed Once” then automatically cleared.
  - g. Provide the ability to name each exception schedule with a user defined term to describe each special event.
4. Trend Log Graphing
- a. All data points (both hardware and software) system-wide shall be assignable to a historical trending program by gathering configurable historical samples of object data stored in the local controller (B-BC, B-AAC, B-ASC).
  - b. All trend log information shall be displayable in text or graphic format. All information shall be able to be printed in black & white or color and exported directly to a Microsoft Excel Spreadsheet.
5. Runtime Log Information
- a. B-OWS Software shall be capable of displaying Runtime and On/Off Cycle data of all Binary data points (both hardware and software) system-wide. Runtime logs shall provide the following at a minimum:
    - 1) Total Accumulated Runtime
    - 2) Accumulated Starts Today
    - 3) Total Accumulated Starts
    - 4) Timestamp each Start/Stop and duration of each on/off cycle
    - 5) Monitor equipment status and generate maintenance messages based upon user designated run time
6. Ability to Manually Override any Database point
- a. All hardware and software points may be temporarily overridden for a user adjustable configured time period
7. Custom navigation file tree

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8. Color Graphical User Interface (GUI)
  - a. All color graphic displays shall be dynamic with current point data automatically updated from the BACnet internetwork to the browser without operator intervention. Manual operator intervention shall use the same methodology as on the B-OWS application.
  - b. Depending upon configured access level; the operator shall be able to manually adjust digital, analog or calculated values in the system, adjust values of control loops, override points or release points to automatic mode.
- O. The NAC shall provide the capability to create individual user (as determined by the log-on user identification) home pages. Provide the ability to limit a specific user to a defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- P. The NAC shall include an Audit Trail feature that automatically records the time, date, and user, and action associated with all user changes made via Web Browser clients.
- Q. The NAC shall store complete help files describing system configuration, and use of the browser interface, the help files shall be served on-line as part of the browser interface.
  1. The web browser interface shall include tool tips to describe the functionality of the interface.

2.2 Advanced Applications Controllers (AAC)

- A. General
  1. Provide a micro-processor based, networkable, custom programmed, BACnet<sup>®</sup> Advanced Application Controller for each split system, wall-mounted where shown on floor-plans. Each AAC shall include an LCD user interface and all input/output points required to monitor and control each unit as a stand-alone system, according to the specified sequence of operation. In addition AAC's shall allow monitoring and remote control via a supervisory network (BACnet) with a WEB-Based Browser-accessible front end.
  2. Provide a 5 year standard manufacturer's warranty for the AAC
- B. Network Protocol and Operator Connections
  1. The AAC's shall allow direct connection to a host network using BACnet<sup>®</sup> MS/TP (EIA-485) protocol. The network communication speed shall be operator selectable up to 76.8 kbps.
  2. Each AAC shall be BTL tested, and listed to meet the B-AAC Standard Device Profile including BIBBs for this level of device. A Protocol Implementation Conformance statement for the AAC proposed shall be submitted along with shop drawings. Network points to be viewable on each AAC are listed in the sequence of operations, however provide a minimum of 32 Read/Write objects per AAC.

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3. Each AAC shall include an externally mounted port allowing operators to connect a laptop computer directly to the AAC for network configuration, custom programming, and trouble-shooting.

C. Hardware Components

1. Provide the following hardware input points at minimum in each AAC:
  - a. Room temperature sensor, local or remote 10K thermistor with an accuracy of +/- 0.1 Deg C
  - b. User set-point adjustment control with programmable set-point limits
  - c. On-board room humidity sensor, with replaceable CMOSense element, overall accuracy of +/- 1.8 % over 10 – 90 % range
  - d. On-board room passive infra-red occupancy sensor, with a maximum detection distance of 5m (16.4 ft), and 64 detection zones
  - e. In addition to the above, provide 4 user-definable universal inputs capable of accepting 0 -5 VDC, 4 – 20 mA, 10K thermistor, or dry contacts. Refer to the sequence of operation for specific input point requirements.
2. Provide hardware analog and digital output points as required by the sequence of operation, however include the following point types at minimum to allow for future expansion:
  - a. Six universal outputs, user-definable as analog or digital
  - b. Two additional digital output points
  - c. Digital output points shall be dry contacts capable of switching 0.5 Amps at 24 VAC.
3. Provide a large LCD screen for display and adjustment of AAC points and mapped network points. Security codes MUST be provided to prevent unauthorized access from the local LCD screen. Minimum LCD size shall be 128 x 64 pixels. The screen shall be back-lit, however the light may be configured to shut off after a programmable inactive time.
4. Provide push-buttons on the panel face to facilitate navigation, point adjustment, data entry, and switching of operational modes (password protected).
5. AAC memory shall include a minimum 64 Kb RAM for logs and temporary data, and 512 kb flash EEPROM for non-volatile storage of firmware configuration and custom database. Provide a 24 hour clock and 365 day calendar on-board. Clock accuracy shall be +/- 1 second over 24 hours, and system time shall be retained during power outages exceeding 7 years.
6. Provide a software configurable buzzer which shall be set-up to trigger on the occurrence of selected alarms, and shall be audible and acknowledgeable either to all users, or only to those users with sufficient password authority.
7. AAC's shall be capable of monitoring and controlling at least 4 networked, remote temperature sensors, each with adjustable set-point and outputs for zone controls. These networked sensors shall not consume input/output points in the AAC.

D. Custom Configuration

1. Each AAC shall allow custom setup of the primary user interface screen; definition of all points to be monitored, controlled and displayed; alarms; schedules; trends; password access; and programmed sequence of operation as required to optimize the AAC for the specific requirements of this project, and

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also to allow future modification by the owner. AAC's using canned programs for pre-determined HVAC applications are not acceptable.

2. Each AAC shall allow the following custom set-up at minimum:
  - a. Primary User Interface screen set-up, including display of time, system mode, fan mode, primary temperature display, and display of up to 3 additional operator-defined AAC or network points.
  - b. ALL physical Inputs AND Outputs of the controller MUST be able to be overridden at the LCD screen for technician checkout of the system locally.
  - c. Seven additional user defined point groups, each including up to six AAC or network points per group, to be displayed and adjusted by system users with sufficient password authority. Each group, and each individual point shall be defined to allow/disallow editing and manual override by users, and the password level required. Point definition shall also determine if units are to be displayed, and whether point names are displayed as text, or alternatively using an icon chosen from an on-board list of industry standard symbols.
  - d. custom programs of 2000 bytes each, using a BASIC control language, with source code stored on board.
  - e. The AAC may be defined with full access by all users without password protection, or with three levels of password protected access. Each level of access shall be enabled by entering a 4 digit password via the front panel keys. AAC's that require removal of the faceplate to unlock the keyboard are not acceptable.
  - f. Alarm states shall be defined using AAC custom programming, with the definition including the password level required to acknowledge, reset, and clear alarms. When an AAC alarm condition exists, an alarm icon shall be displayed on all screens.
  - g. 48 user-definable program-driven variables, with selectable ranges and standard or custom units.
  - h. user-definable PID controls loops
  - i. user-definable trend logs, each with 150 samples of 6 points each, and programmable sampling times
  - j. 8 user-definable runtime logs to accumulate the run-times of selected digital points, and record the time and date of the last 100 changes of state
  - k. 2 user-definable system groups, 50 points per group, allowing related points to be grouped together on one display for use in network graphics
  - l. 1 user-definable weekly schedule, including 4 on/off pairs for each weekday, and two additional daily schedules triggered by the annual schedule or by custom programming
  - m. Override of the unoccupied schedule for a programmed period of time shall be triggered via a front panel button
  - n. 1 annual schedule, allowing pre-programming of holidays 365 days in advance

### 2.3 Input Devices

- A. General Requirements
  1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
  2. Outside Air Sensors

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- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
  - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
  - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
3. Duct Mount Sensors
- a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
  - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
  - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
4. Averaging Sensors
- a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
  - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
  - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
5. Acceptable Manufacturers: Setra or approved equal.
- B. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
  2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
  3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
  4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with seal-tite fittings and stainless steel bushings.
  5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
  6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
  7. Acceptable Manufacturers: Veris Industries, Mamac, or approved equal.
- C. Differential Pressure Transmitters
1. General Air and Water Pressure Transmitter Requirements:
    - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.



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- b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
  - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
  - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
2. Low Differential Air Pressure Applications (0" to 5" w.c.)
- a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - ◇ (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
    - ◇ 4-20 mA output.
    - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
    - ◇ Reference Accuracy: +0.2% of full span.
  - c. Acceptable Manufacturers: Setra or approved equal.
3. Medium Differential Air Pressure Applications (5" to 21" w.c.)
- a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
    - ◇ Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
    - ◇ Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
    - ◇ Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
  - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - c. Acceptable manufacturers: Setra or approved equal.
- D. Flow Monitoring
1. Air Flow Monitoring
- a. Duct Air Flow Measuring Stations
    - ◇ Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
    - ◇ Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet

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per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

- ◇ The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
- ◇ The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
- ◇ The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
- ◇ Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
- ◇ Installation Considerations

(i) The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.

(ii) The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

(iii) Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

(iv) Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.

(v) Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

- ◇ Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.

b. Static Pressure Traverse Probe

- ◇ Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple

- static pressure sensors located along exterior surface of the cylindrical probe.
      - ◇ Acceptable manufacturers: Cleveland Controls or approved equal.
    - c. Shielded Static Air Probe
      - ◇ A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.
- E. Power Monitoring Devices
  - 1. Current Measurement (Amps)
    - a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
    - b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
      - ◇ Operating frequency – 50 - 400 Hz.
      - ◇ Insulation – 0.6 Kv class 10Kv BIL.
      - ◇ UL recognized.
      - ◇ Five amp secondary.
      - ◇ Select current ration as appropriate for application.
      - ◇ Acceptable manufacturers: Veris Industries or approved equal.
    - c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
      - ◇ 6X input over amp rating for AC inrushes of up to 120 amps.
      - ◇ Manufactured to UL 1244.
      - ◇ Accuracy: +.5%, Ripple +1%.
      - ◇ Minimum load resistance 30kOhm.
      - ◇ Input 0-20 Amps.
      - ◇ Output 4-20 mA.
      - ◇ Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
      - ◇ Acceptable manufacturers: Veris Industries or approved equal.
- F. Status and Safety Switches
  - 1. General Requirements
    - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
  - 2. Current Sensing Switches
    - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
    - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

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- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    - d. Acceptable manufacturers: Veris Industries or approved equal.
  - 3. Air Filter Status Switches
    - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
    - b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
    - c. Provide appropriate scale range and differential adjustment for intended service.
    - d. Acceptable manufacturers: Cleveland Controls or approved equal.
  - 4. Air Flow Switches
    - a. Differential pressure flow switches shall be snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
    - b. Acceptable manufacturers: Cleveland Controls or approved equal.
  - 5. Air Pressure Safety Switches
    - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
    - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
    - c. Acceptable manufacturers: Cleveland Controls or approved equal.
  - 6. Low Temperature Limit Switches
    - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
    - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
    - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.4 Output Devices

A. Actuators

- 1. General Requirements
  - a. Damper and valve actuators shall be electronic as specified in the System Description section.
- 2. Electronic Damper Actuators
  - a. Electronic damper actuators shall be direct shaft mount.
  - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal

units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.

- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
- e. Acceptable manufacturers: Belimo or approved equal.

B. Control Dampers

- 1. The BAS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BAS Contractor or as specifically indicated on the Drawings.
- 2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- 4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
- 5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Ruskin CD50 and Vent Products 5650 or approved equal.
- 6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Ruskin CD36 and Vent Products 5800 or approved equal.
- 7. Multiple section dampers may be jack-shafted to allow mounting of direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

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C. Control Relays

1. Control Pilot Relays

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- b. Mounting Bases shall be snap-mount.
- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- d. Contacts shall be rated for 10 amps at 120VAC.
- e. Relays shall have an integral indicator light and check button.
- f. Acceptable manufacturers: Lectro or approved equal.

D. Electronic Signal Isolation Transducers

1. A signal isolation transducer shall be provided whenever an analog output signal from the BAS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies or approved equal.

E. External Manual Override Stations

1. External manual override stations shall provide the following:
  - a. An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
  - b. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
  - c. A Status LED shall illuminate whenever the output is ON.
  - d. An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
  - e. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.5 Miscellaneous Devices

A. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

3. Part 3 – Performance / Execution

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3.1 BAS Specific Requirements

- A. Graphic Displays
  - 1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
  - 2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .
- B. Custom Reports:
  - 1. Provide custom reports as required for this project:
- C. Actuation / Control Type
  - 1. Primary Equipment
    - a. Controls shall be provided by equipment manufacturer as specified herein.
    - b. All damper and valve actuation shall be electric.
  - 2. Air Handling Equipment
    - a. All air handlers shall be controlled with a HVAC-DDC Controller
    - b. All damper and valve actuation shall be electric.
  - 3. Terminal Equipment:
    - a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
    - b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 Installation Practices

- A. BAS Wiring
  - 1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Automation System, as herein specified, shall be provided by the BAS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
  - 2. All BAS wiring materials and installation methods shall comply with BAS manufacturer recommendations.
  - 3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
  - 4. Class 2 Wiring
    - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
    - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

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5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
  6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- B. BAS Line Voltage Power Source
1. 120-volt AC circuits used for the Building Automation System shall be taken from panel boards and circuit breakers provided by Division 16.
  2. Circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.
  3. DDC terminal unit controllers may use AC power from motor power circuits.
- C. BAS Raceway
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.
  2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
  3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
  4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- D. Penetrations
1. Provide fire stopping for all penetrations used by dedicated BAS conduits and raceways.
  2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
  3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
  4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- E. BAS Identification Standards
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.  
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- F. BAS Panel Installation
1. The BAS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer’s recommendations.
  2. The BAS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- G. Input Devices
1. All Input devices shall be installed per the manufacturer recommendation



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2. Locate components of the BAS in accessible local control panels wherever possible.
- H. HVAC Input Devices – General
1. All Input devices shall be installed per the manufacturer recommendation
  2. Locate components of the BAS in accessible local control panels wherever possible.
  3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
  4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
  5. Outside Air Sensors
    - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
    - b. Sensors shall be installed with a rain proof, perforated cover.
  6. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
    - a. Air bleed units, bypass valves and compression fittings shall be provided.
  7. Building Differential Air Pressure Applications (-1" to +1" w.c.):
    - a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
    - b. The interior tip shall be inconspicuous and located as shown on the drawings.
  8. Air Flow Measuring Stations:
    - a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
    - b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
  9. Duct Temperature Sensors:
    - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
    - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
    - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
    - d. The sensor shall be mounted to suitable supports using factory approved element holders.
  10. Space Sensors:
    - a. Shall be mounted per ADA requirements.
    - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
  11. Low Temperature Limit Switches:
    - a. Install on the discharge side of the first water or steam coil in the air stream.
    - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.

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- c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
  12. Air Differential Pressure Status Switches:
    - a. Install with static pressure tips, tubing, fittings, and air filter.
- I. HVAC Output Devices
  1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
  2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke.
  3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
  4. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Automation System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3 Training

- A. The BAS contractor shall provide the following training services:
  1. A minimum of one and a half days (12 hours total) of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BAS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.
  2. Operational training of the BAS shall include at a minimum: changing set points, overrides, starting and stopping equipment, log in to field controllers when the server or PC is down. The BAS contractor shall be required to develop a training outline for this procedure. The training outline, including the lesson plans and course materials, shall be reviewed and approved by the engineer of record through the submittal process.

3.4 Sequence of Operations - Refer to Construction Documents.

ATTACHMENT I

DMZ SECURITY STANDARD

- 1.0 Purpose  
The purpose of this document is to establish requirements that will better manage and secure all platforms within the Orange County Government Board of County Commissioners (OCGBCC). The DMZ is a secure environment with limited access to the OCGBCC internal network.
- 2.0 Scope  
The scope of this document applies to all platforms located within the OCGBCC DMZ.
- 3.0 Policies
  - 3.1 Activity  
Any and all activity within and through the OCGBCC DMZ shall require direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISS-ESU).
  - 3.2 Web Servers  
All internal ISS-ESU policies apply to the OCGBCC DMZ and are augmented by the DMZ Security Standard. The following differences are noted:
    - 3.2.1 Microsoft Internet Information Server (IIS) version 5.0 or higher shall be the only platform within the OCGBCC DMZ to run as a Web or FTP server.
    - 3.2.2 All platforms within the OCGBCC DMZ shall be patched immediately upon the release and testing by the ISS-ESU.
  - 3.3 Administrative Rights  
ISS-ESU shall be the only group with administrative rights to servers in the DMZ.
  - 3.4 Production Servers  
The OCGBCC DMZ shall host production servers only.
  - 3.5 Remote Access  
Remote Access to the OCGBCC DMZ shall be allowed only using Microsoft Terminal Services or Microsoft Remote Desktop protocols.
  - 3.6 Traffic
    - 3.6.1 Internet Activity  
HTTP/HTTPS/FTP/SMTP/IMAPS are the only protocols allowed from the Internet into the DMZ.
    - 3.6.2 Internal Activity  
Traffic using the following protocols from the DMZ to the internal network shall not be allowed: Kerberos, NetBIOS, Microsoft-DS, Microsoft's Well Known Ports (88, 135, 137, 138, 139, 389, 445, 464, 530, 543, 544, 636, 749, 3389), LDAP, RPC, SMB, RDP, HTTP, HTTPS, DNS, JOLT.
    - 3.6.3 Routing
      - 3.6.3.1 All approved access from the DMZ to the internal network shall be routed through a proxy server residing in the DMZ.

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3.6.3.2 The Enterprise DMZ proxy server shall only use firewall conduits to access approved resources within the OCGBCC network.

3.7 Data

- 3.7.1 Any data accessible within the OCGBCC DMZ or directly accessible from it should be encrypted.
- 3.7.2 Any data accessible within the OCGBCC DMZ or directly accessible from it meeting the following criteria shall be encrypted: Name, addresses, phone numbers, email addresses, birthdates, federal/state/local document numbers, account numbers, race or religious information, employee identification numbers and all HIPAA information.
- 3.7.3 The OCGBCC DMZ shall not have access to data containing bank information.
- 3.7.4 The OCGBCC DMZ shall not have access to social security information.
- 3.7.5 The OCGBCC DMZ shall have read only access to live data, if such data is also used by applications residing in the internal OCGBCC network.

4.0 Guidelines

- 4.1 Should databases in policy 3.7.4 need to receive updates by the OCGBCC DMZ, the write operations should be made to a physically separate “staging” data repository. This separate data repository should contain only updates for the specific records being changed. An application server within the internal network should be used to apply the changes in the staging data repository to the live database.
- 4.2 The DMZ should access data repositories in the internal OCGBCC network using SQL database calls.

5.0 Enforcement

Any server found within the OCGBCC DMZ that does not meet the above criteria shall be immediately disconnected from the OCGBCC DMZ. Any employee found to have violated this policy may be subject to disciplinary action, up to and including termination of employment.

6.0 Definitions

<u>Term</u>	<u>Definition</u>
Bank Information	Checking account numbers, credit card numbers, or any unique number from a bank institution.
HTTP	HyperText Transfer Protocol – The underlying protocol used by the World Wide Web. HTTP defines how messages are formatted and transmitted, and what actions web servers and browsers should take in response to various commands.
HTTPS	HyperText Transfer Protocol over Secure Socket Layer (SSL) – By convention, URLs that require an SSL connection start with https: instead of just http:.
FTP	File Transfer Protocol – The protocol for exchanging files over the Internet. FTP works in the same way as HTTP for transferring web pages from a server to a user's browser and SMTP for transferring electronic mail across the Internet in that, like these technologies, FTP uses the Internet's TCP/IP protocols to enable data transfer. FTP is most

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	commonly used to download a file from a server using the Internet or to upload a file to a server.
SMTP	Simple Mail Transfer Protocol – A protocol for sending e-mail messages between servers. In addition, SMTP is generally used to send messages from a mail client to a mail server.
IMAPS	Internet Message Access Protocol – A protocol for retrieving e-mail messages. With IMAP4, you can search through your e-mail messages for keywords while the messages are still on mail server and, then, choose which messages to download to your machine.
LDAP	Lightweight Directory Access Protocol – A set of protocols for accessing information directories.
DNS	Domain Name System (or Service or Server) – An Internet service that translates domain names into IP addresses. Because domain names are alphabetic, they're easier to remember. The Internet however, is really based on numeric IP addresses. Every time you use a domain name, therefore, a DNS service must translate the name into the corresponding IP address.
SQL	Structured query language – SQL is a standardized query language for requesting information from a database.
DMZ	Demilitarized Zone – A computer term used for a protected network that sits between the Internet and the corporate network.
SSL	Secure Sockets Layer – A protocol for transmitting private documents via the Internet. SSL uses a cryptographic system that uses two keys to encrypt data - a public key known to everyone and a private or secret key known only to the recipient of the message.

ATTACHMENT II

ENCRYPTION AND CERTIFICATION AUTHORITIES

- 1.0 Purpose: The purpose of this document is to ensure that all Orange County Government Board of County Commissioner's (OCGBCC) sensitive data is secured by using strong encryption algorithms that have received substantial public review and have been proven to work effectively. Orange County Information Systems and Services Enterprise Security unit (ISS-ESU) provides access to a variety of Encryption Services and Enterprise Certification Authorities (CA).
- 2.0 Scope: This document applies to all data transmitted and stored within the OCGBCC information systems. It applies to all OCGBCC employees, consultants, and all other affiliated third parties operating within the OCGBCC information systems and networks.
- 3.0 Policies:
  - 3.1 Activity:
    - 3.1.1 Any and all activity within and through the OCGBCC information systems involving encryption shall require direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISS-ESU).
    - 3.1.2 The ISS-ESU shall approve the storage and transfer of any data containing personal information and/or residing in the DMZ.
  - 3.2 Encryption Algorithms:
    - 3.2.1 One of the following standard encryption ciphers shall be used to encrypt data. The key length for these algorithms shall be no less than 128bits:
      - Triple-DES (3DES)
      - Rijndael (AES)
      - RSA
      - Blowfish
      - Twofish
      - CAST
    - 3.2.2 PGP is an approved encryption standard provided that the PGP private key used to encrypt and /or sign data has been generated using a cipher meeting the requirements in section 3.2.1.
  - 3.3 Data Hashing  
The following standard data hashing algorithms shall be used to hash data. The key length for the algorithms shall be no less than 128bits.
    - MD5
    - SHA-1
    - SHA-2
  - 3.4 SSL Certificates: Web Server, SSH, IMAPS, SMTPS SSL certificates should have key lengths of no less than 128bits.
  - 3.5 Sensitive Data: Any data containing sensitive information, including, but not limited to: name, addresses, phone numbers, email addresses, birthdates, federal/state/local document numbers, account numbers, race or religious information, employee identification numbers and all HIPAA information, should be encrypted when stored and during network transfers.

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- 3.6 DMZ:
  - 3.6.1 Any and all activity within and through the OCGBCC DMZ shall require direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISS-ESU).
  - 3.6.2 Any data accessible within the OCGBCC DMZ or directly accessible from it should be encrypted.
  - 3.6.3 Any data accessible within the OCGBCC DMZ or directly accessible from it meeting the following criteria shall be encrypted: name, addresses, phone numbers, email addresses, birthdates, federal/state/local document numbers, account numbers, race or religious information, employee identification numbers and all HIPAA information.
- 3.7 Data Backups: Any backup of OCGBCC should be encrypted. Sensitive data as listed in 3.5 of this document shall be backed up using encryption algorithm standards found in 3.2.
- 3.8 Laptops and Removal Devices
  - 3.8.1 All laptop hard drives should be encrypted.
  - 3.8.2 Any sensitive data (see section 3.5 of this document) stored on laptops and removable devices shall be encrypted.
  - 3.8.3 All individuals who work with sensitive data (see section 3.5 of this document) shall have their laptop hard drives encrypted.
- 4.0 Guidelines
  - 4.1 SSL certificates issued to servers and applications used by internet users should be provided by commercial CA authorities (i.e. Verisign, Thawte) to avoid security warnings from being presented to the end users.
  - 4.2 SSL certificates issued to servers and applications used by internal OCGBCC resources should be issued by OCGBCC's Certification Authority.
- 5.0 Enforcement: Any employee found to have violated these policies may be subject to disciplinary action, up to and including termination of employment.
- 6.0 Definitions

<u>Term</u>	<u>Definition</u>
Encryption	Transforming understandable data into a form that is incomprehensible and that looks like random noise.
Hashing	An algorithm that takes an entire message and, through process of shuffling, manipulating, and processing the bytes using logical operations, generates a small message digest of the data.
DMZ	De-Militarized Zone – A computer term used for a protected network that sits between the Internet and the corporate network.  Certification Authority (CA) In cryptography, a certificate authority or certification authority (CA) is an entity which issues digital certificates for use by other parties.

ATTACHMENT III

ANTIVIRUS STANDARDS

- 1.0 Purpose: The purpose of this document is to establish requirements which must be met by all computers connected to the Orange County Government Board of County Commissioners (OCGBCC) network to ensure effective virus detection and prevention.
- 2.0 Scope: This document applies to all OCGBCC computers running any version of the Microsoft Windows Operating Systems. This includes, but is not limited to, all servers, desktop computers, laptop computers, PC-based printers and appliances.
- 3.0 Policy
- 3.1 Virus Software – Servers: Trend Micro Server Protect or Trend Micro OfficeScan shall be installed and enabled on all OCGBCC computers running any server version of the Microsoft Windows Operating Systems.
- 3.2 Virus Software – Workstations: Trend Micro OfficeScan shall be installed and enabled on all OCGBCC computers running any non-server version of the Microsoft Windows Operating Systems.
- 3.3 Virus Software – Exchange Servers: Trend Micro ScanMail shall be installed and enabled on all OCGBCC computers running Microsoft Exchange Server.
- 3.4 Virus Software – Internet Mail: All incoming and outgoing internet email shall be scanned by Trend Micro Interscan Messaging Security Suite before being delivered.
- 3.5 Virus scanning: Antivirus software shall be running at all times on the computers on which it is installed. Real-time scanning of incoming and outgoing files shall be enabled at all times. Antivirus scans of servers shall be executed on a weekly basis in accordance with the schedules set in Trend Micro Server Protect. Antivirus scans of workstations shall be executed on a weekly basis in accordance with the schedules set in Trend Micro OfficeScan.
- 4.0 Guidelines
- When employees receive unwanted and unsolicited emails, they should be deleted and should avoid replying to the sender. These messages should not be forwarded.
  - Employees should never open any files or macros attached to an email from an unknown, suspicious or untrustworthy source. These attachments should be deleted immediately. These messages should not be forwarded.
  - Employees should never download files from unknown or suspicious sources.
- 5.0 Enforcement: Trend Micro's antivirus products are installed on all servers and workstations during the initial installation of the operating systems, and are continuously monitored to ensure they are running. Any employee or temporary found to have willfully stopped and/or paused these programs will be considered to be violating these policies and may be subject to disciplinary action, up to and including termination of employment.

6.0 Definitions

<u>Term</u>	<u>Definition</u>
Virus	A program or piece of code that is loaded onto your computer without your knowledge and runs against your wishes. Viruses can also replicate themselves. All computer viruses are manmade. A simple virus that can make a copy of its self over and over again is relatively easy to produce. Even such a simple virus is dangerous because it will quickly use all available memory and bring the system to a halt. An even more dangerous type of virus is one capable of transmitting itself across networks and bypassing security systems.



ATTACHMENT IV

WEB SECURITY STANDARD

- 1.0 Purpose: The purpose of this document is to establish requirements that will better manage and secure all web server platforms within the Orange County Government Board of County Commissioners (OCGBCC).
- 2.0 Scope: The scope of this document applies to all web server platforms located within the OCGBCC.
- 3.0 Policies
  - 3.1 Activity: Any and all web server installations, removals or modifications shall require the direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISS-ESU).
  - 3.2 Hardware
    - 3.2.1 All hardware platforms operating as a web server shall abide by all standards, policies and guidelines of the OCGBCC Enterprise Systems unit.
    - 3.2.2 All hardware platforms operating as a web server shall reside on server hardware. Any exception shall require a documented wavier by the Information Systems and Services Enterprise Security unit (ISS-ESU).
  - 3.3 Software
    - 3.3.1 Web Server Platforms
      - 3.3.1.1 Microsoft: Microsoft's Internet Information Server (IIS) is the approved, supported web server platform for OCGBCC.
      - 3.3.1.2 Apache Software Foundation: Apache Software Foundation's HTTP Server (Apache) is approved but is unsupported. Any production use of (Apache) shall include an appropriate support model that is approved by the ISS-ESU.
      - 3.3.1.3 Other: Other web server platforms may qualify for use, but shall require an evaluation, approval and a documented wavier by the ISS-ESU.
    - 3.3.2 Databases – Location: A database server shall not reside on the same hardware platform as a web server.
  - 3.4 Security
    - 3.4.1 General: All web servers shall comply with all other documented ISS-ESU standards to include, but not limited to: virus, patch and account management.
    - 3.4.2 Account Management
      - 3.4.2.1 Local Account Access: Only accounts with local administrator privileges shall be allowed to log on locally to a web server.
      - 3.4.2.2 Process/Application Accounts: All web server processes and applications shall run only under a low privilege local account. Web server processes shall not run under an account with domain, power user or a local administrator privileges.
      - 3.4.2.3 Web Server Anonymous Accounts: Web server anonymous accounts shall only have read and execute permissions to folders/files within the

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web server directories. Change and delete permissions to folders/files that are directly accessible via a web browser shall not be granted to web server anonymous accounts.

3.4.3 Permissions

3.4.3.1 Operating System Permissions: ISS-ESU shall secure the operating system's file/folder permissions and security policies of all web servers. These permissions are to be modified solely by ISS-ESU.

3.4.3.2 Vendor/Third Party Access: Local administrator privileges on web servers are for authorized personnel only. Access to vendors and any other third party shall be provided solely on a temporarily, case-by-case basis through ISS-ESU.

3.4.3.3 Developer Access: Developer access to web server content directories shall be available by WebDav or FrontPage server extensions only. Developers shall be granted "Author Pages" rights with the FrontPage Server Extensions

3.4.4 Java Server Engines: Java server engines are approved but are not supported. Any production use of a Java server engine shall include an appropriate support model that is approved by (ISS-ESU).

3.4.5 FTP: Web servers that also run an FTP server shall not map FTP directories to directories accessible via a web browser.

3.4.6 IIS Virtual Directories, Application Pools, Settings: Any and all creations, removals or modifications to IIS Settings, Virtual Directories, Application Directories, and Application Pools shall require the direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISS-ESU).

3.4.7 Other

- Shares are not allowed on any directory accessible via web browser.
- Microsoft Windows web servers and any web application shall not be installed on the same drive as the host operating system.
- Executable files (.exe, .com, .bat, .dll, etc) shall not be placed into directories accessible via a web browser without the direct involvement and documented approval by the Information Systems and Service Enterprise Security unit (ISSESU).

4.0 Guidelines: It is recommended that all web applications use the enterprise FTP and SMTP servers for all FTP/SMTP traffic.

5.0 Enforcement: Any web server not meeting the above criteria may be immediately disconnected from the OCGBCC network. Any employee found to have violated these policies may be subject to disciplinary action, up to and including termination of employment.

6.0 Definitions

<u>Term</u>	<u>Definition</u>
FTP	File Transfer Protocol – The protocol for exchanging files over the Internet. FTP works in the same way as HTTP for transferring Web pages from a server to a user's browser and SMTP for transferring electronic mail across the Internet in that, like these technologies, FTP uses the Internet's TCP/IP protocols to enable data transfer. FTP is most commonly used to download a file from a server using the Internet or to

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upload a file to a server.

- WebDav                      Web-based Distributed Authoring and Versioning – Extensions to HTTP that allows users to collaboratively edit and manage files on remote Web servers.
- Front Page Extensions    A series of scripts that can be employed using Microsoft FrontPage, a visual HTML editor.
- SMTP                         Simple Mail Transfer Protocol – A protocol for sending e-mail messages between servers. In addition, SMTP is generally used to send messages from a mail client to a mail server.

ATTACHMENT V

STANDARDS SUMMARY

The following is a summary of key points in the Orange County Government Board of County Commissioners (OCGBCC) security standards. It is necessary for vendors to completely understand and follow these requirements in order for products or services to be considered for placement within the OCGBCC environment. Complete details about these standards can be found in the Orange County Government Standards and Guidelines packet.

WEB SERVERS

Web and Database Placement

A database server shall not reside on the same hardware platform as a web server.

Anonymous Accounts

Web server anonymous accounts shall only have read and execute permissions to folders/files within the web server directories. Change and delete permissions to folders/files that are directly accessible via a web browser shall not be granted to web server anonymous accounts.

DMZ

Web Server Platforms

Microsoft Internet Information Server (IIS) version 5.0 or higher shall be the only platform within the OCGBCC DMZ to run as a Web or FTP server.

Services and Protocols

Traffic using the following protocols from the OCGBCC DMZ to the internal network shall not be allowed: Kerberos, NetBIOS, Microsoft-DS, Microsoft's Well Known Ports, LDAP, RPC, SMB, RDP, HTTP, HTTPS, DNS, JOLT.

Encrypted Data

Any data accessible within the OCGBCC DMZ or directly accessible from it meeting the following criteria shall be encrypted: Name, addresses, phone numbers, email addresses, birthdates, federal/state/local document numbers, account numbers, race or religious information, employee identification numbers and all HIPAA information. The OCGBCC DMZ shall not have access to data containing bank information. The OCGBCC DMZ shall not have access to social security information.

Data Access

The OCGBCC DMZ shall have read only access to live data, if such data is also used by applications residing in the internal OCGBCC network.

ANTIVIRUS

Virus scanning

Antivirus software shall be running at all times on the computers on which it is installed.

MICROSOFT SECURITY PATCHES

Patch Installation

MS Security patches may be applied immediately upon release by Microsoft. All vendors must support their applications in this environment.

ATTACHMENT VI

DESKTOP COMPUTING STANDARDS

AUTHORIZED PRODUCTS

1: HARDWARE

Dell Desktop minitower and small form factor (SFF) PC

- ◆ Dell GX960
  - ◆ Energy Smart system enabled
  - ◆ Intel Core 2 Duo processor or better
  - ◆ Minimum 2 Gb of Memory
  - ◆ Maximum 4 Gb Memory
  - ◆ USB Keyboard and Mouse
  - ◆ 160 GB SATA Hard drive
  - ◆ DVD+/- RW
  - ◆ 4 Year Basic Limited Warranty and 4 year Onsite Service
  - ◆ Intel vPro enabled

Dell Laptop

- ◆ Dell Latitude e6510
  - ◆ Intel Core 2 Duo processor or better
  - ◆ Minimum 2 Gb of Memory
  - ◆ Maximum 4 Gb of memory
  - ◆ CD-RW/DVD
  - ◆ 80 GB Hard Drive
  - ◆ 4 Year Limited Warranty and 4 year Onsite Service
  - ◆ Intel vPro enabled
- ◆ Dell Latitude e4300
  - ◆ Intel Centrino Core 2 Duo processor
  - ◆ Minimum 2 Gb memory
  - ◆ Maximum 4 Gb memory
  - ◆ CD-RW/DVD
  - ◆ 80 Gb Hard Drive
  - ◆ 4 Year Limited Warranty
  - ◆ Intel vPro enabled
    - *All PCs with 4yr limited warranty*
- ◆ PDAs- Blackberry Devices Only

2: OPERATING SYSTEMS and PROTOCOLS

Desktop/Laptop

- ◆ Microsoft Windows 7 Professional with IE 8 (for new PCs)
- ◆ Microsoft Windows XP Service Pack 3 (for existing PCs)
- ◆ Internet Explorer 8.0- *IE8 is current County Standard included with Windows 7. IE7 is available for backwards compatibility.*
  - ◆ *Application software may specifically require a certain Internet Explorer version. Contact ISS for assistance as needed. [ServiceCenter@ocfl.net](mailto:ServiceCenter@ocfl.net)*
- ◆ Microsoft Office 2003 or greater (Standard or Professional Suite)

Portable Devices

- ◆ Blackberry OS

Network Connectivity

- ◆ Cisco Wireless Access Points, Cisco 802.11 LAN Card
- ◆ TCP/IP

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- ◆ Sprint Wireless AirCard

3: CLIENT DATABASES

Desktop/Workstations Only, Single User Only

- ◆ Microsoft Access (user databases not supported)
- ◆ Oracle Client
- ◆ SQL Server Client

4: PERIPHERALS and ACCESSORIES

- ◆ HP LaserJet series
  - ◆ Black and White LaserJet
    - ◆ P1606dn < 4 users
    - ◆ P3015dn (supports secure printing – PIN)
    - ◆ P4015dn 8+ users (supports secure printing – PIN)
  - ◆ Color LaserJet
    - ◆ CP2025dn
    - ◆ CP4525dn 7+ users (supports secure printing – PIN)
    - ◆ 5550dn 15+ users (supports secure printing – PIN)
- ◆ *Desktop Copier and combo unit purchases directly connected to the PC must be reviewed and approved by ISS. Contact [ServiceCenter@ocfl.net](mailto:ServiceCenter@ocfl.net) for more information and assistance.*

UNSUPPORTED PRODUCTS

1: HARDWARE

- ◆ Pre-Pentium class desktop systems
- ◆ Non-Dell PCs
- ◆ Non-Blackberry Smartphones

2: OPERATING SYSTEMS AND PROTOCOLS

- ◆ Microsoft Windows 2000
- ◆ Microsoft Windows NT 4.0
- ◆ Microsoft Windows 3.x, Windows 95 and 98
- ◆ MAC OS

3: CLIENT DATABASES

- ◆ Dbase
- ◆ RBASE
- ◆ Paradox
- ◆ FOXPRO

4: DESKTOP APPLICATIONS

Desktop/Workstation

- ◆ MS Office platforms prior to Office 2000
- ◆ ProComm
- ◆ Microsoft Internet Explorer, 4.x, 5.x
- ◆ McAfee Viruscan *\*Trend Micro is OCGOV standard*
- ◆ WordPerfect
- ◆ Quattro
- ◆ Hotmetal
- ◆ Freelance
- ◆ Harvard Graphics
- ◆ Lotus Suite
- ◆ Netscape, Opera, Firefox Browsers

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- ◆ Rumba
- ◆ LAN Workplace
- ◆ Exceed
- ◆ Visio 3.x and older
- ◆ SHL Vision & Vision Express, WIN9x/WINNT/UNIX
- ◆ McAfee Remote Desktop32
- ◆ Reflection version 9 or lower
- ◆ PC Anywhere

5: PERIPHERALS AND ACCESSORIES

- ◆ HP LaserJet Series 4 and older printers
- ◆ Inkjet printers

PROHIBITED PRODUCTS

1: HARDWARE

- ◆ Personal (non-County) PCs
- ◆ Any network (voice or data) device not operated, administered or expressly approved by Orange County ISS.
- ◆ Any internet access device not operated, administered or expressly approved by Orange County ISS.

2: OPERATING SYSTEM AND PROTOCOLS

- ◆ Windows 9x
- ◆ Windows Vista
- ◆ 64 bit operating systems

Network Protocols

- ◆ NETBUI
- ◆ AppleTalk
- ◆ Token Ring
- ◆ Any network (voice or data) software or service not operated, administered or expressly approved by Orange County ISS.
- ◆ Any internet access service not operated, administered or expressly approved by Orange County ISS.

3: APPLICATIONS

- ◆ Any Alpha/Beta Software not operated, administered or expressly approved by Orange County ISS
- ◆ Anti-virus products other than Trend Micro
- ◆ Personal firewall products
- ◆ Network scanning tools
- ◆ Remote access software other than ISS authorized VPN
- ◆ User installed screen savers
- ◆ Games
- ◆ 3<sup>rd</sup> Party Desktops
- ◆ Disk Compression
- ◆ Non-Static BITMAP Backgrounds or screen savers
- ◆ iTunes (or other content sharing applications)
- ◆ P2P software

4: PERIPHERALS AND ACCESSORIES

- ◆ Portable music devices
- ◆ Personal (non-County) mass storage devices (hard drives, thumb drives, etc)
- ◆ Webcams

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SECTION 15950  
SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Provide all labor, material, documentation and services required for the implementation of the Sequences of Operation detailed herein.

1.3 APPLICABLE PROVISION

- A. Where modulation of a valve or damper is referred to then it shall mean the direct digital control of the valve or damper based on a control algorithm resident in the BCS software at the remote field panel. Unless noted otherwise the control algorithm shall be PID control. Optimum loop response shall be ensured by the use of a built in automatic loop tuner.
- B. An Operator having the required level of password access shall be able to modify the Operator changeable or definable parameter(s) on-line from an I/O device such that the monitoring and control functions of the BCS shall not be affected during the period of the change. The mechanism by which the change is made shall be simple and shall be adequately described in the Operator's manuals. Where setpoints for control parameters such as setpoint or changeover temperatures, humidities, or times are referred to in this Section they shall be Operator changeable on-line.
- C. Where the sequences refer to the start/stop of a system this shall be initiated either by an Operator manually entered command or automatically by a software routine such as "Optimum Stop/Start", "Power Demand Control", "Programmed Stop/Start", etc. or via an interlock in the sequences of operation to other equipment or event(s).
- D. When the motor controller is equipped with a HOA the motors shall only be controlled by the BCS when the HOA switch is in the auto position.
- E. Firestats, freezestats, smoke and fire detectors and interlocked dampers shall be wired to shutdown motors when the HOA switch is in both the hand and auto positions. It shall not be possible for the BCS to override these or any other safety devices or any fire alarm system control functions, except in the case of an engineered smoke control system in which case freeze protection safeties shall be overridden.
- F. Refer to the Point Definition Sheets and System Schematics, which form part of these Contract Documents, to facilitate the interpretation of the sequences of operation as defined herein.
- G. Provide additional I/O points, whether or not such points are indicated in the Point Definition Sheets, if they are required in order to attain the requirements of the Contract Documents.
- H. Where fans and dampers are to be interlocked, provide hardwire interlocks between the motor terminal strip and damper such that the damper shall be driven open when the motor is required to start. Motor start-up shall not occur until the damper end switch indicates the damper is in the full open position.



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- I. Where fans and dampers are hardwire interlocked, the interlocks shall apply in both the "hand" and "auto" positions of the HOA switch at the motor controller.
- J. Where electric heat coil control calls for the electric heating coil to be staged/cycled on and off to maintain the required temperature set point, the control algorithm shall incorporate a deadband, changeable by the Operator, which shall prevent the too frequent on/off cycling of the heating coil.
- K. Where electric heating coils are controlled by the BCS, the BCS shall not override any safety interlocks.
- L. Where there are fans not identified within the sequence of operation, point definition sheets or schematic drawings that provide supply and/or exhaust air that are not controlled via a thermostat, they shall be hardwire interlocked to the controlling device. The supply fans shall be hardwire interlocked with their associated exhaust fan (if applicable) to operate simultaneously. The dampers shall be hardwire interlocked with the fans via end switches such that the fans cannot operate when the damper is not fully open. The damper status shall not be monitored by the BCS. If the supply or exhaust fan serves a riser with multiple dampers, the end switches of the riser dampers shall be wired in parallel as a group then wired in series with the fan's associated damper end switch to prevent the fan from operating unless both the fan's damper is open and at least one of the riser dampers are open.
- M. The point list is provided for convenience and is not intended to be all-inclusive. All points required to provide the Sequence of Operation shall be included as if listed.
- N. All wiring required to provide the Sequence of Operation shall be included.

1.5 ABBREVIATIONS

AFD	Adjustable Frequency Drive
AUX	Starter Auxiliary Contact
AI	Analog Input
AO	Analog Output
CFM	Air Flow in CFM from Air Monitor
CSR	Current Sensing Relay
D	Damper Operation
DI	Digital Input
DO	Digital Output
DP	Differential Pressure
ES	End Switch
Fa	Failure Alarm
FR	Freezestat
FS	Flow Switch
H	Humidity Sensor
Ha	High Static Pressure Alarm
IAQ	Indoor Air Quality
IGV	Inlet Guide Vanes
La	Low Static Pressure Alarm
Ma	Maintenance Alarm
Pd	Discharge Static Pressure
Pdd	Downduct Static Pressure
Pds	Discharge Static Pressure Safety
Ps	Suction Static Pressure

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Pss	Suction Static Pressure Safety
R	Relay
Sa	Safety Alarm/Shut-down
SD	Smoke Detector
DP	Static Pressure Sensor
SR	Damper Smoke Rated
SS	Start-Stop
T	Temperature Sensor
Ta	Temperature Alarm
V	Valve Operator
VP	Virtual Point
X	Hardwired Item

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 SEQUENCE OF OPERATION – Refer to Construction Documents.

END OF SECTION 15950

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SECTION 16010  
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes Basic Electrical Requirements specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements - and any supplemental requirements/conditions.

1.3 DESCRIPTION OF WORK

- A. The work required under this Division shall include all materials, labor and auxiliaries required to install a complete and properly operating electrical system.
- B. The Contractor shall furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the correct installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.
- C. The Division 16 Contract Documents refer to work required in addition to (or above) the minimum requirements of the NEC and applicable local codes. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.
- D. Only trained, and licensed personnel shall be used by the Contractor to perform work. The Contractor shall not perform work, which violates applicable Codes, even if called for in the Contract Documents. The Contractor's Bid shall include work necessary to completely install the electrical systems indicated by the Contract Documents in accordance with applicable Codes.
- E. Refer to other Division 16 Sections for additional work requirements.
- F. Connections of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.
- G. The Contractor shall provide and install panic hardware on all electrical room doors where the electrical room houses equipment rated 1200 amps or more per NEC 110.26. All electrical room doors shall open in the direction of egress.

1.4 WORK SEQUENCE

- A. Install work in stages and/or phases to accommodate Owner's occupancy requirements. Coordinate electrical schedule and operations with Owner and Architect/Engineer.

1.5 CODES, FEES, AND STANDARDS

- A. Conform to all applicable requirements of Section Reference Standards and Regulatory Requirements.
- B. Obtain permits and request inspections from authority having jurisdiction and applicable utility

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companies.

- C. Pay for all required licenses, fees, and inspections.
- D. Material shall be new and free of defects with UL listing or be listed with an approved, nationally recognized Electrical Testing Agency if and only if UL Listing is not available for material.

1.6 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown or described in the Contract Documents, unless prevented by Project conditions.
- B. The Contractor shall install all equipment so that all Code required and Manufacturer recommended servicing clearances are maintained. Contractor shall be responsible for the proper arrangement and installation of all equipment within any designated space. Should the Contractor determine that a departure from the Contract Documents is necessary, he shall submit to the A/E, for approval, detailed drawings of his proposed changes with his written reasons for the changes. No changes shall be implemented by the Contractor without the issuance of the required drawings, clarifications, and/or change orders.
- C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.7 INVESTIGATION OF SITE

- A. Check site and existing conditions thoroughly before bidding. Advise A/E of discrepancies or questions noted.
- B. Each Bidder shall visit the site and shall thoroughly familiarize himself with existing field conditions and the proposed work as described or implied by the Contract Documents. During the course of the site visit, the electrical bidder shall verify every aspect of the proposed work and the existing field conditions in the areas of construction and demolition which will affect his work. The Contractor will receive no compensation or reimbursement for additional expenses he incurs due to failure to make a thorough investigation of the existing facilities. This shall include rerouting around existing obstructions.
- C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.
- D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Contractor shall field verify dimensions of all site utilities, conduit routing, boxes, etc., prior to bidding and include any deviations in the contract. Notify A/E if deviations are found.
- E. All existing electrical is not shown. The Contractor shall become familiar with all existing conditions prior to bidding, and include in his bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is not being reused, back to its originating point.
- F. The Contractor shall locate all existing utilities and protect them from damage. The Contractor shall pay for repair or replacement of utilities or other property damaged by operations in conjunction with the completion of this work.
- G. All items removed and not re-used shall be immediately turned over to Owner as they are made available by renovation(i.e. the MDP breakers being removed to make room for new AHU and CU breakers). Remove items from job site and deliver to Owner's storage location(s) as directed by project manager. Discard complete items which Owner elects to refuse.
- H. Investigate site thoroughly and reroute all conduit and wiring in area of construction in order to

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maintain continuity of existing circuitry. Existing conduits indicated in Contract Documents indicate approximate locations only. Contractor shall verify and coordinate existing site conduits and pipes prior to any excavation on site. Bids shall include hand digging and all required rerouting in areas of existing conduits or pipes.

- I. Work is in connection with existing buildings which must remain in operation while work is being performed. Work shall be in accord with the schedule required by the Contract. Schedule work for a minimum outage to Owner. Notify Owner 72 hours in advance of any shut-down of existing systems. Perform work during non-operating hours unless otherwise accepted by Owner. Protect existing buildings and equipment during construction.
- J. Bid shall include all removal and relocation of all piping, fixtures or other items required for completion of alterations and new construction.
- K. See 16060 for additional requirements due to existing conditions.

1.8 CONTRACT DOCUMENTS

- A. These specifications and applicable drawings shall be considered supplementary, one to the other and are considered Contract Documents. All workmanship, methods, and/or material described or implied by one and not described or implied by the other shall be furnished, performed, or otherwise provided just as if it had appeared in both sets of documents.
- B. Where a discrepancy or conflict is found between these specifications and any applicable drawing, the Contractor shall notify the A/E in written form. In the event that a discrepancy exists between specifications and any applicable drawing, the most stringent requirement shall govern unless the discrepancy conflicts with applicable codes wherein the code shall govern. The most stringent requirement shall be that work, product, etc which is the most expensive and costly to implement.
- C. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner.
- D. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All wiring and appurtenances required for the proper operation of all equipment to be connected shall be provided.
- E. Specifications require the Contractor to provide shop drawings which shall indicate the fabrication, assembly, installation, and erection of a particular system's components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, Code requirements, or applicable standards.
- F. Locations indicated for outlets, switches, and equipment/equipment disconnects are approximate and shall be verified by instructions in specifications and notes on the drawings. Where instructions or notes are insufficient to locate the item, notify the A/E.
- G. The Contractor shall take finish dimensions at the project site in preference to scaling dimensions on the drawings.
- H. Where the requirements of another Division, section, or part of these specifications exceed the requirements of this Division those requirements shall govern.

1.9 MATERIALS AND EQUIPMENT

- A. Material shall be new (except where specifically noted, shown or specified as "Reused") and/or denoted as existing) and shall be UL listed and bear UL label. Where no UL label listing is available for a particular product, material shall be listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of

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equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

- B. Where Contract Documents list design selection or manufacturer, type, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to A/E's review and acceptance. Where Contract Documents list accepted substitutions, these items shall comply with Section 16013 and requirements in this Division of the Specifications for substitutions.
- C. When a product is specified to be in accordance with a trade association or government standard and at the request of A/E the Contractor shall furnish a certificate that the product complies with the referenced standard and supporting test data to substantiate compliance.
- D. Where multiple items of the same equipment or materials are required, they shall be the product of a single Manufacturer.
- E. Where the Contract Documents require materials and/or equipment installed, pulled, or otherwise worked on, the materials and/or equipment shall be furnished and installed by the Contractor responsible for Division 16 methods and materials unless specifically noted otherwise.
- F. Where the contract documents refer to the terms "furnish," "install," or "provide," or any combination of these terms) the materials and/or equipment shall be supplied and delivered to the project including all labor, unloading, unpacking, assembly, erection, anchoring, protecting supplies and materials necessary for the correct installation of complete system unless specifically noted otherwise.
- G. Before the Contractor orders equipment, the physical size of specified equipment shall be checked to fit spaces allotted on the drawings, with NEC working clearances provided. Internal access for proposed equipment substitutions shall be provided.
- H. Electrical equipment shall be protected from the weather during shipment, storage, and construction per manufacturer's recommendations for storage and protection. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner. No additional time will be allowed and the project completion date shall be maintained.
- I. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor with no additional cost to the Contract.
- J. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material and/or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.
- K. Where the Contract Documents denote equipment and/or material to be 'new' and/or 'existing' and also provide no denotation for other equipment as to it being 'new' and/or 'existing,' this is not to infer that the non-denoted equipment is either new or existing, or opposite of the equipment that is denoted. The use of the terms 'new' or 'existing' is meant to clarify denoted equipment/materials for that item only, and the lack of the terms 'new' or 'existing' in relation to identifiers/notes/denotations on the drawings is not to infer that this non-denoted equipment or materials is new or existing.

1.10 MISCELLANEOUS CIRCUITS REQUIRED

- A. Provide 120 volt, 20 amp circuit to all fire alarm panels, remote panels, or new power supplies (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest

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120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with fire alarm system engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

1.11 SUPERVISION OF THE WORK

- A. Reference the General Conditions for additional requirements.
- B. The Contractor shall provide experienced, qualified, and responsible supervision for work. A competent foreman shall be in charge of the work in progress at all times. If, in the judgement of the A/E, the foreman is not performing his duties satisfactorily, the Contractor shall immediately replace him upon receipt of a letter of request from the A/E. Once a satisfactory foreman has been assigned to the work, he shall not be withdrawn by the Contractor without the written consent of the A/E.
- C. Provide field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable size and complexity. Superintendent shall be on the site at all times during construction and must have, as a minimum, an active Journeyman's Electrical License in the State of Florida.
- D. Superintendent shall be employed by a currently licensed Florida Certified Electrical Contractor (EC) or a currently licensed Florida Registered Electrical Contractor (ER).

1.12 COORDINATION

- A. Provide all required coordination and supervision where work connects to or is affected by work of other trades, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
  - 1. Mechanical Division of the Specifications
  - 2. Fire Alarm
  - 3. Millwork design drawings and other discipline shop drawings
- B. Contractor shall obtain set of contract documents from Owner for all areas of work noted above and include all electrical work in bid whether included in Division 16 Contract Documents or not.
- C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the A/E prior to installation of the equipment for final resolution.
- D. For locations where several elements of electrical or combined mechanical and electrical work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings at 1/4" scale showing the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. Coordination drawings shall be provided for all areas of conflict as determined by the A/E.
- E. Secure accepted shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on accepted shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.
- F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner and the contract time for completion will not be extended.

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- G. The Contractor shall maintain an up-to-date set of Contract Documents (Drawings and Specifications) of all trades on the project site, including Architectural, Structural, Mechanical, Electrical and, where provided Interior Design.
- H. It is the responsibility of this Contractor to coordinate the exact required location of all roof penetrations, VFDs, floor stub-ups, etc. with Owner and Architect (and receive their written approval) prior to rough-in. Locations indicated in Contract Documents are approximate.
- I. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). The Contractor shall coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. The Contractor shall adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes due to these coordination efforts shall be made at no additional cost to the Owner.

1.13 PROVISION FOR OPENINGS

- A. Locate openings required for work. Provide sleeves, guards or other accepted methods to allow passage of items installed.
- B. Coordinate with roofing Contractor on installation of electrical items which pierce roof. Roof penetrations shall not void roof warranty.
- C. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types with Contractor prior to installation.

1.14 SURFACE MOUNTED EQUIPMENT

- A. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have factory applied finish and/or shall be painted as directed by Engineer. Paint shall be in accordance with other applicable sections of the specifications for this project.

1.15 CUTTING AND PATCHING

- A. New Construction:
  - 1. Reference Division 1 - General Requirements.
  - 2. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.
  - 3. The Contractor shall be responsible for backfilling and matching new grades with adjacent undisturbed finished surface.
- B. Existing Construction:
  - 1. See Section 16060 for additional requirements.

1.16 TRENCHING(if required)

- A. All trench excavations in excess of 5 feet deep shall comply with OSHA Standard 29 CFRs 1926.650 Subpart P.

1.17 INSTALLATION

- A. Erect equipment to minimize interferences and delays in execution of the work.
- B. Take care in erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the A/E at no additional



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cost to the Owner.

- C. Equipment requiring electrical service shall not be energized or placed in service until A/E is notified and is present or have waived their right to be present in writing. Where equipment to be placed in service involves service or connection from another Contractor or the Owner, the Contractor shall notify the Owner in writing when the equipment will be ready. The Owner shall be notified as far in advance as possible of the date the various items of equipment will be complete.
- D. Equipment supports shall be secured and supported from structural members except as field accepted by the A/E in writing.
- E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to dry wall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.
- F. The Contractor shall keep the construction site clean of waste materials and rubbish at all times. Upon completion of the work, the Contractor shall remove from the site all debris, waste, unused materials, equipment, etc.
- G. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and a layout made prior to the setting or embedment thereof, so as to cause no delay to the project schedule.

1.18 PROGRESS AND RECORD DRAWINGS

- A. Keep two sets of blueline prints on the job, and neatly mark up design drawings each day as components are installed. Different colored pencils shall be used to differentiate each system of electrical work. Cost of prints and this labor task shall be included under this Division. All items on Progress Drawings shall be shown in actual location installed. Change the equipment schedules to agree with items actually furnished.
- B. Prior to request for substantial completion observation, furnish a set of neatly marked prints showing "as-installed" (as-built) condition of all electrical installed under this Division of the specifications. Marked up prints are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Marked up set of prints to show:
  - 1. All raceways 1-1/2" and above, exactly as installed.
  - 2. All site raceways exactly as installed.
  - 3. Any combining of circuits (which is only allowed by specific written permission) or change in homerun outlet box shall be made on as-builts.
  - 4. Any circuit number changes on plan shall be indicated on as-builts.
  - 5. Any panelboard schedule changes shall be indicated on as-builts and final panelboard schedules..
- C. Marked up prints as noted above are to be submitted to A/E for review.. Contractor shall review submitted "as-builts" with Engineer in the field. Contractor shall verify every aspect for accuracy.
- D. The changes and alterations shall be transferred to AutoCAD (Auto CAD Release 2007 or higher). Obtain CAD disk of the construction documents by the A/E, from the A/E. generate/update the CAD disks to include all changes, additions, etc. on the accepted marked up prints. Label each drawing "As-Built" and date. Submit as-built CAD disk and reproducible of the

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as-builts.

- E. After acceptance of marked up prints by A/E with all changes, additions, etc. included on accepted marked up prints, submit set prior to request for final payment and/or request for final observation.
- F. Where the Contractor has failed to produce representative "as-built" drawings in accordance with requirements specified herein, the Contractor shall reimburse Engineer all costs to produce a set of "as-built" drawings to the Architect/Owner satisfaction.

1.19 OBSERVATION OF WORK REPORT

- A. Reference the General Conditions.
- B. Items noted by A/E or his representative during construction and before final acceptance which do not comply with the Contract Documents will be listed in a "Observation of Work" report which will be sent to the Contractor for immediate action. The Contractor shall correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item to the A/E. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing request for payments.
- C. Items noted after acceptance during one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.20 SYSTEMS WARRANTY

- A. Reference the General Conditions.
- B. The work shall include a one-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material which has been furnished at no cost to the Owner for a period of one year from the date of substantial completion of each System. Warranty shall not include lamps in service after one month from date of substantial completion of the System. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the Owner upon project completion.
- C. Where items of equipment or materials 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.
- D. Where extended warranty or guarantee are called for herein, furnish three copies to be inserted in Operation and Maintenance Manuals.
- E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.21 WASTE MATERIALS DISPOSAL

- A. Contractor shall include in his bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and guidelines applicable. Contractor shall comply fully with Florida statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal. Contractor shall provide owner with written certification of accepted disposal.

1.22 SUBSTANTIAL COMPLETION

- A. The Contractor shall be fully responsible for contacting all applicable parties Engineer or Project Manager to schedule required observations of the work by Engineer. A minimum of 72 hours notice shall be given for all required observations of the work by Engineer, and minimum of 120

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hours for substantial completion observation. Time and date shall be agreed on by all applicable parties in writing.

- B. Work shall be complete as required by authorities having jurisdiction and the general conditions of the contract prior to request for substantial completion observation. Work must be deemed substantially complete by A/E to fulfill requirements.

1.23 PROHIBITION OF ASBESTOS AND PCB

- A. The use of any process involving asbestos or PCB, and the installation of any product, insulation, compound of material containing or incorporating asbestos or PCB, is prohibited. The requirements of this specification for complete and operating electrical systems shall be met without the use of asbestos or PCB.
- B. Prior to the final review field visit, the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 16 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed and dated by a duly authorized agent of the manufacturer.

PART 2 - PRODUCTS (Not Applicable)

PART 3- EXECUTION (Not Applicable)

END OF SECTION

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SECTION 16012  
SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Requirements for submittals specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements and any supplemental requirements/conditions.
- B. See Section 01631 Products/Substitutions for additional requirements when submittal consists of accepted substitution equipment.

1.3 SUBMITTAL OF "ACCEPTED SUBSTITUTE" EQUIPMENT/PRODUCT

- A. Representation: In submitting item, equipment, product, etc. that has been listed on contract drawings, in contract documents or in an addenda, Contractor represents that he:
  - 1. Has investigated substituted item and has determined that it is equal or superior to specified product in all aspects and that use of substituted item will not require any additional time to the Contract.
  - 2. Will coordinate installation of accepted substitution into work, making changes as may be required to complete work in all aspects.
  - 3. Waives all claims for additional costs related to substitution which may subsequently become apparent.
  - 4. Will provide the same warranties for the substitution as for the product specified.
  - 5. Will absorb all costs incurred by the substitution when affecting other trades including but not limited to electrical, structural, architectural, etc.
  - 6. Will absorb any cost incurred by the Engineer in review of the substituted product if the acceptance of the substituted item creates the need for system modification and/or redesign, or if the substituting contractor exhibits negligence in his substituting procedure thus submitting inferior, misapplied or miss-sized equipment. In the event of additional engineering costs, the billing structure shall be agreed upon prior to review by all involved parties.
- B. Substitutions that cannot meet space requirements or other requirements of these Specifications, whether accepted or not, shall be replaced at the Contractor's expense with no additional time added to the Contract.

1.4 SUBMITTALS

- A. Refer to Section 01300 Submittals for requirements.
  - 1. Items requiring shop drawings include (but not limited to):
    - a) Lightning protection system
    - b) Each section of 16700 broad section (i.e., fire alarm, television, etc.).
    - c) Special and/or modified equipment
    - d) Main switchboard(s)
    - e) UL listed fire and smoke stopping assemblies for each applicable penetration

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2. See specific sections of Specifications for further requirements.
3. Product Data: Technical data is required for all items as called for in the Specifications regardless if item furnished is as specified.
  - a) Submit technical data verifying that the item submitted complies with the requirements of the Specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate all optional equipment and changes from the standard item as called for in the Specifications. Furnish drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.
  - b) In order to facilitate review of product data, insofar as practicable, they shall be noted, indicating by cross reference the contract drawings, note, and/or specification paragraph numbers where and/or what item(s) are used for and where item(s) occur in the contract documents.
  - c) See specific sections of Specifications for further requirements.

1.5 PROCESSING SUBMITTALS

- A. Refer to Section 01300 Submittals.
- B. Submit under provisions of the General Requirements of the Contract and this section of the Specifications, whichever is the most strict.
- C. Quantity of submittals with marking on each copy shall be submitted under provisions of General Requirements of the Contract, Division 1, and this and other sections of the Specifications. Submittal must contain:
  1. Project Addresses
  2. Index
  3. Separation Sheets
  4. Basic Materials
  5. Panelboards
  6. Light Fixtures
  7. Long Lead Items
  8. Systems Product Data
- D. Remainder of submittals are to be submitted no later than 60 days after award of contract or 60 days prior to Request for Substantial Completion whichever is earlier.
- E. The Contractor shall review all submittals before submitting to the A/E. No request for payment will be considered until the submittals have been reviewed and submitted for approval.
- F. Product Data: For standard manufactured materials, products and items, submit one (1) copy or sets of data (per binder). If submittal is rejected, resubmittal shall contain same quantity of new data.
- G. Shop Drawings: For custom fabricated items and systems (16700) shop drawings, initially submit a transparency (suitable for reproduction) together with two (2) prints made therefrom. When submittal is acceptable, furnish one (1) print per binder made from the accepted transparency.
- H. Shop Drawing Review Notation.

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<u>Action</u>	<u>Description</u>
1. No Exception Noted	No exceptions taken. Resubmittal not required.
2. Rejected	Not in compliance with Contract Documents. Resubmit.
3. Submit Specific Item	Resubmit item as specified.
4. Make Corrections Noted	Make corrections noted, resubmittal not required.
5. Revise and Resubmit	Make corrections noted, resubmittal is required
6. Review not Required	Not required for review. No action taken. Copy retained for reference.

- I. Acceptance: When returned to Contractor, submittals will be marked with A/E's stamp. If box marked "Rejected" "Revise and Resubmit" or "Submit Specific Item" is checked, submittal is not accepted and Contractor is to correct and resubmit as noted, otherwise submittal is accepted and Contractor is to comply with notation making necessary corrections on submittal. Review comments will generally not be on each individual submittal sheet, and will be on a separate sheet attached to shop drawing transmittal, submittal as a whole or each submittal section.
- J. Note that the acceptance of shop drawings or other information submitted in accordance with the requirements specified above, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved or the Mechanical/Electrical performance of equipment. Acceptance of shop drawings does not invalidate the plans and Specifications if in conflict, unless a letter requesting such change is submitted and accepted on the Engineer's letterhead.

1.6 DELAYS

- A. Contractor is responsible for delays in job progress accruing directly or indirectly from late submissions or resubmissions of shop drawings, or product data.

1.7 RE-SUBMITTALS

- A. The A/E shall be reimbursed for all costs to review resubmittals subsequent to the second submission for the same product. Cost will be billed to Contractor at Engineer's standard hourly rate.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION

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SECTION 16013  
SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies general, administrative and procedural requirements for substitutions for Division 16 sections above and beyond the requirements of Division 1 General Requirements and any Supplemental requirements/conditions.
- B. Request for substitutions must be submitted no later than 10 days prior to bid due date.
- C. Request for substitution will not be considered after bid due date.

1.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Products, materials, equipment, finishes, and methods of construction are considered substitutions if they meet any one of the following conditions:
  - 1. Does not meet all the requirements of these specifications under Part 1 - General or Part 2 - Products for any section included in Division 16 - Electrical Specifications.
  - 2. Is a different design which accomplishes the same result as that design specified in Division 16 - Electrical Specifications.
  - 3. Is of similar or different design that:
    - a) Requires more space.
    - b) Requires more power.
    - c) Requires changes in other elements of the work such as (but not limited to) architectural, mechanical, structural, or other electrical work.
    - d) Affects the construction schedule.
  - 4. Is listed in these specifications on the Contract Documents or in any addenda as an accepted substitution.

1.4 REQUEST FOR SUBSTITUTION SUBMITTALS (10 Days Prior to Bid Due Date)

- A. A separate request for substitutions shall be submitted for each product, material, etc. that is defined as a substitution.
- B. Submittal must consist of written request for substitution with data as required below. Request must be very specific as to what specified item, request for substitution is submitted for.
- C. Each request for substitution submittal for each product, etc. shall include:
  - 1. Name of material or equipment for which it is to be substituted.
  - 2. Drawings, product data, performance data and/or other information necessary for the engineer to determine that the equipment meets all specifications and requirements.
  - 3. Compliance Statement. Each request shall include the following compliance statement typed on letterhead of submitting company:

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- a) Submittal complies with all aspects/requirements of Contract Documents. (Yes or No). If no, state deviance.
- b) Submittal complies with all applicable codes. (Yes or No). If no, state deviance.
- c) Submittal complies with all other elements of the work and does not require any other changes. (Yes or No). If No, state required change.
- d) Meets or exceeds the performance of specified product. (Yes or No). If no, state required change.

1.5 REQUEST FOR SUBSTITUTION SUBMITTALS (AFTER BID)

- A. Substitution requests submitted after bid will not be reviewed.
- B. Submittals for items noted as an Accepted Substitution on Contract Drawings, these specifications, or listed in an addenda, shall be submitted as required in Section 16012 - Submittals.

1.6 CONSIDERATION AND ACCEPTANCE

- A. Request for substitutions will not be considered if:
  - 1. Submittal does not comply with all requirements as noted above or contain all information required above.
  - 2. If submittal does not contain Compliance Statement, fully filled out.
  - 3. If Compliance Statement contains a 'no' or 'N'.
  - 4. Submittals are submitted beyond time limitations noted above.
- B. Samples.
  - 1. Sample may be required to be submitted, if deemed necessary by the A/E to determine if the substitution meets specifications.
  - 2. Where required by A/E on an individual basis, samples may be required after written notice of acceptance and approval has been made of each substitution.
  - 3. The A/E reserves the right to reject sample and consequently the substitution should the sample not meet the requirement of the contract documents.
- C. Substitutions will be considered on basis of design, concept of the Work, and overall conformance with information given in Contract Documents, including but not limited to:
  - 1. Design criteria, which shall be equal or superior to the specified item.
  - 2. Finishes, which shall be identical or superior to finishes of specified product.
  - 3. Physical size and dimension which are identical or within design criteria limitations as determined by the Engineer.
- D. The Engineer's decision on acceptance or rejection of substitutions will be final.
- E. Substitution requests, if accepted will be included in an addenda.
- F. Approval of a substituted item or listing a substituted item as an accepted substitution, does not modify or act as a waiver in any way, the requirements of the contract documents. See Section 16012 for additional requirements on accepted substitution submittals, equipment, etc.
- G. The naming of any manufacturer as an accepted substitution does not imply automatic approval as a substitution. It is the sole responsibility of the Contractor to ensure that any price quotations received and submittals made are for systems that meet or exceed these specifications.



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PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 16014  
REFERENCE STANDARDS AND REGULATORY REQUIREMENTS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Reference Standards and Regulatory Requirements specifically applicable to Division 16 sections.

1.3 REFERENCES

- A. The following references may be referenced within these specifications:

AASHTO	American Association of State Highway and Transportation Officials
ACA	American Correctional Association
ADA	Americans with Disabilities Act
AHCA	Agency for Health Care Administration
AHERA	Asbestos Hazard Emergency Response Act
AIA	American Institute of Architects
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	ASME International American Society of Mechanical Engineers International
ASTM	ASTM International American Society for Testing and Materials International
BOCC	Board of County Commissioners Orange County
DCA-ADAIA	Department of Community Affairs - Florida Americans with Disabilities Accessibility Implementation Act
DCA-ADAAG	Department of Community Affairs - Florida Americans with Disabilities Act Accessibility Guidelines
DCA-ARM	Department of Community Affairs - Accessibility Requirements Manual
DER Rule 17-762	Department of Environmental Regulation, Chapter 17-762 on Above Ground Storage Tank Systems.
DOCA or DCA	State of Florida Department of Community Affairs

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EIA/TIA	Electronics Industries Alliance/Telecommunications Industry Association
EJCDC	Engineers Joint Contract Documents Committee American Consulting Engineers Council
FAC	Florida Administrative Code
FBC	Florida Building Code
FEMA	Federal Emergency Management Agency
FFPC	Florida Fire Prevention Code
FLA	State of Florida
FMG	FM Global (formerly Factory Mutual System)
FS	Florida Statutes
ICC	International Code Council
IEEE	Institute of Electrical and Electronics Engineers, Inc
ICPEA	International Power Cable Engineer's Association
LPI	Lightning Protection Institute
LTCR	Local Telephone Company Requirements
NECPA	National Energy Conservation Policy Act
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OCS	Orange County Schools Design Guidelines
OSHA	The Occupational Safety and Health Act
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFSRS	Uniform Fire Safety Rules and Standards of Insurance Division of State Fire Marshal
UL	Underwriters Laboratories, Inc.
NEC	National Electrical Code
FAC	Florida Administrative Codes, Chapter 33-8, Rules of the Department of Corrections, County and Municipal Detention Facilities.

1.4 REGULATORY REQUIREMENTS

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- A. Conform to all the applicable requirements of the following codes, standards, guidelines, etc.. If there should be conflicting requirements between these codes, standards, guidelines, etc., the more or most stringent requirement shall apply that does not violate any codes or laws.
1. Standards and Miscellaneous Codes/Requirements (Comply with latest edition or notice available unless otherwise adopted by Authority Having Jurisdiction):
    - a) Americans with Disabilities Act of 1990, as amended
    - b) ADA Standards for Accessible Design, 2010
    - c) American National Standards Institute
    - d) American Society of Heating, Refrigerating and Air Conditioning Engineers
    - e) American Society of Mechanical Engineers
    - f) American Society for Testing and Materials
    - g) Concrete Reinforcing Steel Institute
    - h) Department of Community Affairs
    - i) Florida Building Code, 2010
    - j) Florida Fire Prevention Code, 2010
    - k) Institute of Electrical and Electronics Engineers
    - l) Local Power Company Requirements
    - m) Lightning Protection Institute
    - n) Local Telephone Company Requirements
    - o) National Electrical Code, 2008
    - p) National Energy Conservation Policy Act
    - q) National Electrical Safety Code
    - r) National Electrical Manufacturers Association
    - s) NFPA 1 Fire Code, 2009
    - t) NFPA 101 Life Safety Code, 2009
    - u) Occupational Safety and Health Act
    - v) Safety Code for Elevators and Escalators  
A17.1a, 2008 and A17.1b, 2009 Addenda
    - w) Sheet Metal and Air Conditioning Contractors
    - x) Underwriters Laboratories, Inc.
    - y) Applicable Federal, State, Local Codes, Laws and Ordinances, Florida Statutes and Referenced Codes/Standards

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 16015  
ELECTRICAL SYMBOLS AND ABBREVIATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Symbols and abbreviations specifically applicable to all Division 16 sections in addition to those in Division 1 - General Requirements and any supplemental requirements/conditions.

1.3 SYMBOLS

- A. In general the symbols used on the drawings conform to the Standard Symbols of the Institute of Electrical and Electronic Engineers with the exception of special systems or agencies as hereinafter noted.
  - Corps of Engineers.
  - Special Symbols as shown in schedules or legends.

1.4 ABBREVIATIONS

- A. The following abbreviations or initials are used.
  - A/C Air Conditioning
  - AFD Adjustable Frequency Drive
  - AC Alternating Current
  - ADD # Addendum #
  - A/E Architect/Engineer (or Engineer when Architect not applicable)
  - AFF Above Finished Floor
  - AFG Above Finished Grade
  - AHU Air Handler Unit
  - AIC Amps Interrupting Capacity
  - AL Aluminum
  - ALT Alternate
  - AMP Ampere
  - ANSI American National Standards Institute
  - AWG American Wire Gauge
  - @ At
  - B.C. Bare Copper
  - BIDS Baggage Information Display System
  - BLDG Building
  - BRKR Breaker
  - BTU British Thermal Unit
  - BTUH BTU Per Hour
  - C Conduit
  - CB Circuit Breaker
  - CBM Certified Ballast Manufacturers
  - CCTV Closed Circuit Television
  - cd Candela
  - CFM Cubic Feet per Minute
  - CH Chiller
  - CKT Circuit
  - CKT BRKR Circuit Breaker

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C/L Center Line  
Clg Ceiling  
Comp Compressor  
Conn Connection  
Cond Condenser  
Cont Continuous  
CRI Color Rendering Index  
CT Current Transformer  
CU Copper  
CU Compressor Condenser Unit  
CW Cold Water  
DB Direct Burial  
DC Direct Current  
Disc Disconnect  
DN Down  
DPST Double Pole Single Throw  
DWG Drawing  
EC Electrical Contractor (or General Contractor)  
ELEV Elevator  
EMT Electrical Metallic Tubing  
Equip Equipment  
EST Estimate  
FAAP Fire Alarm Annunciator Panel  
FACP Fire Alarm Control Panel  
FARP Fire Alarm Remote Panel  
FATC Fire Alarm Terminal Cabinet  
FCCP Fire Alarm Command Center Panel  
FHC Fire Hose Cabinet  
FIDS Flight Information Display System  
FLA Full Load Amperes  
FT Feet  
FLR Floor  
FC Footcandles  
FVNR Full Voltage Non-Reversing  
GAL Gallon  
Galv Galvanized  
GPH Gallons per Hour  
GPM Gallons per Minute  
GFI Ground Fault Interrupting  
GRS Galvanized Rigid Steel Conduit  
GND Ground  
HTG Heaters  
HT Height  
Hz Hertz (Cycles)  
HPF High Power Factor  
HPS High Pressure Sodium  
HP Horsepower  
HR Hour  
HS Heat Strip  
ICTC Intercom Termination Cabinet  
IMC Intermediate Metallic Conduit  
Incand Incandescent  
in Inches  
JB Junction Box

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kVA KiloVolt Ampere  
kW Kilowatts  
kWH Kilowatt Hour  
K Kelvin  
LLD Lamp Lumen Depreciation  
LED Light Emitting Diode  
LIU Light Interface Unit (Fiber Optic Patch Panel)  
LT Light  
LTG Lighting  
LTS Lights  
LPF Low Power Factor  
MCB Main Circuit Breaker  
MLO Main Lugs Only  
Maint Maintenance  
MH Manhole; Metal Halide  
MFG Manufacturer  
max Maximum  
MCM/KCMIL Thousand Circular Mils  
MPH Miles Per Hour  
MM Millimeter  
Min Minimum  
MCP Motor Circuit Protector  
MTD Mounted  
N Neutral  
NEC National Electrical Code  
NEMA National Electrical Manufacturers Association  
NFPA National Fire Protection Association  
NPT National Pipe Thread  
NF Non Fused  
NC Normally Closed  
NO Normally Open  
NIC Not in Contract  
No. Number  
OB Outlet Box  
OD Outside Diameter  
OL Overload  
OLS Overloads  
OS&Y Outside Screw and Yoke (Sprinkler)  
% Percent  
Ø Phase  
P Pole  
PL Compact Fluorescent Lamp  
PT Potential Transformer  
PSF Pounds per Square Foot  
PSI Pounds per Square Inch  
PB Pullbox  
PNL Panel  
PR Pair  
Pri Primary  
PTZ Pan, Tilt, Zoom  
PVC Polyvinyl Chloride  
Recept Receptacle  
RPM Revolutions per Minute  
RS Rapid Start

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SCA Short Circuit Amps  
Sec Secondary  
SHT Sheet  
S/N Solid Neutral  
SPST Single Pole Single Throw  
SF Square Foot  
SW Switch  
SWBD Switchboard  
Sys System  
THHN; THWN Nylon Jacketed Wire  
TSP Twisted Shielded Pair  
TTB Telephone Terminal Board  
TTC Telephone Terminal Cabinet  
TV Television  
TVTC Television Terminal Cabinet  
TVEC Television Equip. Cabinet  
TYP Typical  
Temp. Temperature  
UL Underwriters' Laboratories  
UTP Unshielded Twisted Pair  
VFD Variable Frequency Drive  
VHF Very High Frequency  
VHO Very High Output  
V Volt  
VA Volt Amperes  
Vol. Volume  
VV Video Visitation  
W Wire  
W.P. Weatherproof  
XFMR Transformer  
Y Wye  
Yd Yard  
Yr Year  
3R Rainproof  
4X Stainless Steel Dusttight, Watertight

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION



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SECTION 16060  
MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the requirements for electrical demolition.
- B. Provide and install all equipment, labor, material, accessories, and mounting hardware for completion of minor electrical demolition for remodeling.

1.3 REFERENCES

- A. NFPA 70 National Electrical Code
- B. Underwriters Laboratories

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner, Engineer at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- D. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and to remake connections. Notify Owner, Engineer and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. For the full period of time the system is deactivated, a safety fireman's watch is required to be provided to enact a fire watch for areas that experience a loss of fire protection and notification coverage due to the modifications.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

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- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring completely to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.
- F. Seal openings in walls, floors, etc. and fire stop in accordance with the accepted UL detail to maintain integrity of assembly.
- G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate and as required to comply with the requirements of the NEC.
- H. Extend existing installations using materials and methods compatible with existing electrical installations. Extension must meet or exceed the materials/methods specified in the contract documents.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused, including but not limited to:
  - 1. Panelboards: In panel boards in which work is being done, clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

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SECTION 16061  
INVESTIGATION OF EXISTING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes testing and documentation of existing electrical systems.

1.3 REFERENCES

- A. IEEE Recommended Practices

1.4 DESCRIPTION

- A. Test the essential features of the following existing electrical systems:
  - 1. Alarm and bells.
  - 2. Fire detection devices, smoke detection devices.
  - 3. Controls and alarms.
  - 4. Building grounding systems.
- B. Each system shall be tested once only, and after completion of testing, results given to the Owner, Engineer and/or Owner's representative. Point out any non-operational function noticed during testing.
- C. Document the existing conditions and operation of the existing electrical systems prior to any work.
- D. Contractor is responsible for all non-working systems and their components unless non-working status is verified prior to work on system.

1.5 TIME

- A. The testing shall be held at a date to be agreed upon in writing by the Owner or his Representative.

1.6 ATTENDING PARTIES

- A. The testing shall be held in the presence of the Owner, or his Representative and Contractor.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PERFORMANCE VERIFICATION

- A. Test the operation of each of the following existing devices and associated systems:
  - 1. Fire Alarm System:
    - a) Test each pull station and record location of each tested device, and note either operational or non operational.
    - b) Test each heat detector and record location of each tested device and note either operational or non operational.
    - c) Test each duct mounted smoke detector with canned smoke and verify alarm activation, remote pilot light activation and damper operation. Record location of each tested device and note either operational or non operational.

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- d) Test each smoke detector with canned smoke and record location of each tested device and note either operational or non operational.
  - e) Test tamper switches by closing the valve until signal is activated and verify trouble signal indication at the fire alarm control panel and annunciators. Record location of each tested device and note either operational or non operational.
  - f) Upon alarm activation verify that the fire alarm zone lights and audible/visual signals function properly. Verify that the local fire department or responding agency receives an automatic signal.
  - g) Test Fire Alarm System sufficiently to determine existing operating condition of system. Pull the pull stations, check automatic detectors. Test minimum of one manual device per zone, and one automatic device per zone.
  - h) Upon alarm activation verify that the fire alarm zone lights and audible/visual signals function properly. Verify that the local fire department or responding agency receives an automatic signal.
2. Wiring Devices (Outlets) In Areas of Remodel and/or Renovation:
- a) Test receptacles for continuity, open grounds, open neutrals etc. Use circuit testers and record location and results of tested device.
3. Ground System:
- a) Test ground system at each permanent building and at each modular unit/building.
  - b) Submit Ground Test Information Form (included at the end of this section) for every grounding system in the project. This includes, but is not limited to:
    - 1. Ground rod installation.
    - 2. Water pipe and ground installation (test water pipe to ground and test water pipe to building service equipment).
    - 3. Building steel ground connection (test building steel to ground and test building steel to building service equipment).
  - c) Testing shall be 3-point method in accordance with IEEE recommended practice.
  - d) Where grounding resistance is greater than value required by this Specification, Contractor is to bring this to the attention of the Engineer and Owner in wiring, along with the Ground Test Information Form.
- B. The Electrical Contractor shall investigate all existing systems as called out in this performance verification prior to the beginning of any work which could affect these systems.
- C. Each system shall be retested after completion of remodel and/or renovation to ensure proper operation is maintained. Demonstrate operation per Section 16095 Demonstration of Completed Electrical Systems.

3.2 INVESTIGATION/TESTING FORMS

- A. Submit Existing Facilities Investigation Form and advise Owner/Engineer of all deficiencies in system(s) prior to work. All systems will be assumed to be fully operational if Form not received by Engineer prior to work on system.
- B. Submit five copies of the Existing Facilities Investigation Form for each device tested, signed by the Contractor, Subcontractor and Owner, and submit each test result to the Owner's Authorized Representative.

Attachments:  
Existing Facilities Investigation  
Ground Test Information

END OF SECTION

**EXISTING FACILITIES INVESTIGATION**

PROJECT: \_\_\_\_\_

The existing systems on the above project have been investigated and checked to determine the existing condition of all existing electrical systems within the area(s) affected by the scope of work of this project. The investigation consisted of testing all electrical systems/devices as required by Section 16061 Investigation of Existing Electrical Systems.

All equipment was found to be operational except as noted herein (list below):

\_\_\_\_\_  
PRIME CONTRACTOR

\_\_\_\_\_  
AUTHORIZED SIGNATURE AND TITLE

DATE \_\_\_\_\_

\_\_\_\_\_  
OWNER'S AUTHORIZED REPRESENTATIVE

\_\_\_\_\_  
AUTHORIZED SIGNATURE AND TITLE

DATE \_\_\_\_\_

Note To Contractor: Upon completion of investigation and one week prior to the commencement of work, submit five copies of the completed Existing Facilities Investigation Form to the Owner's Authorized Representative, signed and dated by the Contractor. The Owner's Authorized Representative's signature and date is required to verify receipt of Form. Retain copy(ies) and submit copy of Form in each Operation and Maintenance Manual. Contractor shall submit quantities of Forms as required to present required information.

**GROUND TEST INFORMATION**

PROJECT NAME \_\_\_\_\_

GROUND TYPE \_\_\_\_\_

TEST BY \_\_\_\_\_

DATE OF TEST \_\_\_\_\_

GROUND LOCATION: \_\_\_\_\_

GROUND TYPE (Rod, Water pipe, etc.) \_\_\_\_\_

PRIOR TO CONNECTION TO SYSTEM

GROUND \_\_\_\_\_ (OHMS)

AFTER CONNECTION TO SYSTEM

GROUND \_\_\_\_\_ (OHMS)

WEATHER CONDITIONS (Wet/Dry) \_\_\_\_\_

SOIL CONDITIONS (Wet/Dry) \_\_\_\_\_

\_\_\_\_\_  
CONTRACTOR'S REPRESENTATIVE

DATE \_\_\_\_\_

\_\_\_\_\_  
ENGINEER'S REPRESENTATIVE

DATE \_\_\_\_\_

\_\_\_\_\_  
OWNER'S REPRESENTATIVE

DATE \_\_\_\_\_

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SECTION 16090  
TESTS AND PERFORMANCE VERIFICATION OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section pertains to the furnishing of all labor, materials, equipment and services necessary to test and prove performance of the electrical system.
- B. Operate system for a three day period. Do performance verification work as required to show that the system is operating correctly in accordance with design. Supply instruments required to read data. Adjust system to operate at the required performance levels.

PART 2 - PRODUCTS (Not Applicable)

PART 3- EXECUTION

3.1 TESTS

A. System:

1. General: After installation of all conductors and before final acceptance, make required tests to determine proper functioning of all circuits. Furnish all necessary instruments required to make tests and correct any deficiencies found. Prior to energizing, circuits shall be "rung-out" to verify opens, intentional and non-intentional grounds, continuity and detect short circuits by accepted constant megger.
2. Procedure:
  - a) All wires in conduit that are shorted or unintentionally grounded shall be replaced.
  - b) Insulation resistance of all feeder conductors and all conductors shall be tested. **This is to include all new conductors and all existing conductors that are connected or extended.** Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps, and connections are made, except connection to source and point of final termination at distribution or utilization equipment.
  - c) Insulation resistance of conductors that are to operate at 600 volts or less shall be tested by using AVO Biddle (or accepted equal) megger at not less than 1000 volts dc. Resistance shall be measured from conductor to conduit (ground). Testing methodology shall conform to short-time or spot-reading procedural recommendations of AVO Biddle Instruments for specific megger being used. Acceptable insulation resistance of conductors rated at 600 volts shall not be less than 1 megohm.
  - d) Conductors that do not satisfy test requirements of paragraph c) above, shall be removed, replaced, and testing repeated on new cable at no additional cost to the Owner. All tests shall be performed by licensed electrician trained in the use of test instruments. Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed and complete Conductor Insulation Resistance Test form (see Section 16098 Operation and Maintenance Manuals) and submit five copies to Engineer for acceptance. Test shall be witnessed by Owner's Representative and Engineer (if so desired). Final acceptance data is to be submitted in O & M Manual.

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- e) Test reports shall identify each feeder conductor tested, date, time, and result of test, weather conditions and range, test voltage, and serial number of the megger instrument used. Any conductor or splice that is found defective shall be promptly removed and replaced and an additional test shall be performed.
- f) Observe all safety instructions set by testing equipment manufacturer. Application of voltage testing involves risk of electric shock and sparking.

B. Motors:

- 1. Test run each motor via motor's control unit in both manual mode and automatic mode. Verify proper operation, voltage and rotation.
- 2. Test run each motor furnished under this Division of the Specifications and all existing motors specifically noted on the Drawings and/or Specifications to be tested:
  - a) With the system energized, line-to-line voltage and line current measurements shall be made at the motors under full load conditions. Should measured values deviate +/- 10% from the nameplate ratings, the condition shall be corrected. Notify the Engineer immediately should deviations occur.
  - b) Record results of existing motors tested and submit values to A/E in writing.
  - c) Test the insulation resistances of all motor windings to ground with a megger before applying line voltage to the motors. If these values are less than 1 megohm, the Contractor furnishing the motor shall be responsible for correcting the error.
  - d) Determine power factor of motor(s) at full load.
  - e) Tabulate readings, complete Motor Test Information form (see Section 16098 Operation and Maintenance Manuals) and submit five copies to the Engineer for acceptance. Final accepted data is to be submitted in O & M Manual.

C. Grounds:

- 1. Test each raceway for raceway continuity as called for in Section 16170 Grounding and Bonding.
- 2. Test each grounding system used in the project as called for in Section 16170 Grounding and Bonding.
- 3. Submit Ground Test Information form (see Section 16098 Operation and Maintenance Manuals) for every grounding system in the project, including but not limited to, each ground rod installation; each water pipe and ground installation (test water pipe to ground and test water pipe to building service equipment), and each building steel ground connection (test building steel to ground and test building steel to building service equipment).
- 4. Grounding resistance shall be as called for in Section 16170 Grounding and Bonding.
- 5. Testing shall be 3-point method in accordance with IEEE recommended practice.
- 6. Transformer grounding.

END OF SECTION



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SECTION 16095  
DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the requirements for demonstration of completed electrical systems:

1.3 DESCRIPTION

- A. Demonstrate to Owner the essential features of the following electrical systems:
  - 1. Fire Alarm Systems
    - a) Demonstrate that Fire Alarm Shut down relays are properly functioning.
  - 2. Electrical Entrance Equipment
    - a) Circuit breakers
    - b) Fuses and fuseholders
    - c) Meters (where applicable)
  - 3. Lightning Protection System
  - 4. Distribution Equipment
    - a) Lighting and appliance panelboards
    - b) Distribution panels
    - c) Switchboard
    - d) Voltage stabilizers
  - 5. Wiring Devices
    - a) Low-voltage controls
    - b) Switches: regular, time
- B. Upon completion of testing, each system is to be demonstrated only once.

1.4 TIME

- A. The demonstration shall be held upon completion of testing of all systems at a date to be agreed upon in writing by the Owner or his representative.

1.5 ATTENDING PARTIES

- A. The demonstration shall be held by this Contractor in the presence of the Owner and the manufacturer's representative.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DEMONSTRATION

- A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.
- B. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.
- C. Performance Verification and Demonstration to Owner
  - 1. Submit Check Out Memo form for each item, equipment, and system. Copy to be included in each Operation and Maintenance Manual.

END OF SECTION

**CHECK OUT MEMO**

Check Out Memo shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration Meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name \_\_\_\_\_

Type of Equipment Checked \_\_\_\_\_

Equipment Number \_\_\_\_\_

Equipment Manufacturer \_\_\_\_\_

Signature below by the manufacturer's authorized representative signifies that the equipment has been satisfactorily tested and checked out on the job by the manufacturer.

1. The attached Test and Data and Performance Verification information was used to evaluate the equipment installation and operation.
2. The equipment is properly installed, has been tested by the manufacturer's authorized representative, and is operating satisfactorily in accordance with all requirements, except for items noted below.\*
3. Written operating and maintenance information has been presented and reviewed in detail with the Contractor.
4. Sufficient copies of all applicable operating and maintenance information, parts lists, lubrication checklists, and warranties have been furnished to the Contractor for insertion in the Operation and Maintenance Manuals.

**CHECKED BY:**

\_\_\_\_\_  
MANUFACTURER'S REPRESENTATIVE (print)

\_\_\_\_\_  
ADDRESS

\_\_\_\_\_  
TELEPHONE, FAX, E-MAIL

\_\_\_\_\_  
MANUFACTURER'S REPRESENTATIVE (signature, title)

\_\_\_\_\_  
DATE CHECKED

**WITNESSED BY:**

\_\_\_\_\_  
CONTRACTOR'S REPRESENTATIVE (signature, title)

**\*EXCEPTIONS NOTED AT TIME OF CHECK-OUT (USE ADDITIONAL PAGE IF NECESSARY)**

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SECTION 16098  
OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 and Division 16 Specification Sections apply to this Section.
- B. The requirements in this section of the specifications are in addition to all requirements in sections referenced above.

1.2 SUMMARY

- A. This section includes the requirements for Operation and Maintenance Manuals (O & M Manuals) specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements and any supplemental requirements/conditions.

1.3 OPERATION AND MAINTENANCE MANUALS

- A. O& M Manuals shall consist of a minimum of one (or if required) two hard cover view type 3-ring binder(s) sized to hold 8 1/2" x 11" sheets; one (1) for ELECTRICAL OPERATION AND MAINTENANCE (Power and Lighting) (black); one (1) for SYSTEMS OPERATION AND MAINTENANCE (Sections 16700 thru 16799) (blue). Where SYSTEMS OPERATION AND MAINTENANCE (Sections 16700 thru 16799) is not applicable, only one (1) binder is required. Refer to Division 1, general requirements for additional requirements.
  1. Each binder is to be adequately sized to comfortably hold required submittals. Minimum spline size to be 1", maximum spline size to be 3". Provide additional binders if 3" size is not sufficient to properly hold submittals.
  2. Binder cover and spline to have outer clear vinyl pockets. Provide correct designation of project in each pocket; see Binder Examples for O & M's at the end of this Section. Description sheet is to be white with black letters, minimum of 11" high and full width of pocket. Description is to describe project and match project drawing/project manual description. Description to include submittal type, i.e. ELECTRICAL OPERATION AND MAINTENANCE for Power and Lighting, (and if required) SYSTEMS OPERATION AND MAINTENANCE for Sections 16700 - 16799.
- B. O & M Data:
  1. Manufacturer's operation and maintenance data is required for all items as called for in the specifications. O & M Manuals shall include manufacturer's name, model number(s), characteristics, manufacturer's agent, service agent, supplier, where and/or what item(s) are used for and description (i.e. surge suppression - switchboard MDPA).
  2. Include troubleshooting instructions, list of special tools required, theory of operation, manufacturer's care and cleaning, preventative maintenance instructions, wiring diagrams, and point-to-point schematics.
- C. O & M Manuals to include:
  1. Completed forms and information per Division 1, General Requirements, and this section of the specifications.
    - a) Table of Contents
    - b) Project Addresses
    - c) Reinforced Separation Sheets tabbed with the appropriate specification reference number and typed index for each Section in the Systems Schedule
    - d) Check Out Memo
    - e) Conductor Insulation Resistance Test Memo
    - f) DC High Voltage Cable Test Report
    - g) Ground Test Information

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- h) Motor Test Information
  - i) Voltage and Amperage Readings Tabulated Data.
  - j) Progress and Record Drawing Certification
  - k) Spare Parts Certification Memo
2. Shop Drawings: Shop drawings shall be a copy of the final and accepted shop drawing submitted as required in Section 16012 "Submittals". These shall be inserted in binder in proper order.
  3. Product Data: Product data and/or Catalog sheets shall be a copy of the final and accepted submittal submitted as required in Section 16012 "Submittals". These shall be inserted in binder in proper order.
  4. Warranty/Guarantee: Provide copy of warranty/guarantee in respective location in O & M binder, (Power and Lighting) (Systems). Original warranty/guarantee is to be incorporated into separate project warranty book with warranty/guarantees provided for other sections and divisions of the specifications and submitted for Architectural/Owner acceptance.
  5. Copies of electrical panel schedules and electrical panel directories included with the corresponding specification section
  6. Wiring diagrams, schematic, etc. inserted in proper order, for:
    - a) Control devices, motor controls.
    - b) Panelboards.
    - c) Distribution panelboards.
    - d) Each and every part of the Systems sections of these Specifications, 16700 thru 16799.
  7. For Section 16100 thru 16199:
    - a) Product data and/or catalog sheets on all equipment applicable to this project.
    - b) Equipment supplier list for each section's equipment.
  8. Sections 16400 thru 16499:
    - a) Product data and/or catalog sheets on equipment applicable to this project.
    - b) Equipment supplier list for each sections equipment.
    - c) Panels, distribution panelboards, switchboards; in addition to above provide:
      1. Internal wiring diagrams.
      2. Bus diagrams.
      3. Operation and maintenance requirements, instructions, and recommended testing.
      4. Parts list.
      5. Copy of directory.
      6. Voltage and Amperage Readings Tabulated Data Form
      7. Check-Out Memo Form
    - d) Overcurrent protective devices; in addition to above provide the following for large circuit breakers:
      1. Parts list.
      2. Operation and maintenance requirements.
      3. Wiring diagrams.
      4. Testing data.
      5. Installation/removal instructions.
      6. Check-Out Memo Form
    - e) Motor Control; in addition to above provide the following:
      1. Internal wiring diagrams.
      2. Wiring diagrams.
      3. Bus diagrams.
      4. Operation and maintenance requirements, instructions, and recommended testing.

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5. Parts list.
6. Copy of directory.
7. Testing data, motor test information sheets.
8. Check-Out Memo Form

9. Section 16600:

- a) Product data and/or catalog sheets on all equipment applicable to this project.
- b) Equipment supplier list for each sections equipment.
- c) Lightning Protection System: In addition to the above provide:
  1. Shop drawing.
  2. Product data on all components.
  3. Parts list.
  4. Operation and maintenance procedures.
  5. Copy of lightning protection system master label.
  6. Installer's name, address, etc.
- d) Surge Suppression:
  1. Product data and/or catalog sheets on equipment applicable to this project.
  2. Parts list.
  3. Recommended testing and replacement procedures.

10. Sections 16700 thru 16799

- a) Installer's name, address, phone, etc. for each system.
- b) Authorized representatives name, address, phone, etc. for each system.
- c) Equipment supplier's name, address, phone, etc. for each system.
- d) Surge Suppression.
  1. Product data and/or catalog sheets on equipment applicable to this project.
  2. Parts list.
  3. Recommended testing and replacement procedures.
- e) Fire Alarm, Sound/Paging, Television, Security, Closed Circuit systems.
  1. Product data and/or catalog sheets on equipment applicable to this project.
  2. Parts list.
  3. Installation/removal instructions.
  4. Wiring diagrams of panels.
  5. Point-to-point wiring diagrams of system.
  6. Operation and maintenance requirements.
  7. Shop drawing as submitted and accepted in submittal process.
  8. Check-Out Memo Form

1.4 PROCESSING SUBMITTALS

- A. Submit a minimum of three (3) sets of O & M Manuals, two (2) sets for Owner, one (1) set for Engineer.
- B. The Contractor shall review the manuals before submitting to the A/E. No request for payment will be considered until the brochure has been reviewed and submitted for acceptance.
- C. Provide additional copies if additional copies are required in other Divisions and/or sections of these specifications.

1.5 DELAYS

- A. Contractor is responsible for delays in job project accruing directly or indirectly from late submissions or resubmissions of shop drawings, or product data.

1.6 RESUBMITTALS

- A. The A/E shall be reimbursed cost to review re-submittals subsequent to the second submittal.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

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PROJECT ADDRESSES

OWNER:

ARCHITECT:

CONSULTING ENGINEER:

Matern Professional Engineering, Inc.  
130 Candace Drive  
Maitland, Florida 32751  
Telephone No.: (407) 740-5020  
Fax No.: (407) 740-0365

GENERAL CONTRACTOR:

SUBCONTRACTOR:

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CHECK OUT MEMO FORM

This form shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name:

Type of equipment checked:

Equipment Number:

Name of manufacturer of equipment:

Signature below by the manufacturer's authorized representative signifies that the equipment has been satisfactorily tested and checked out on the job by the manufacturer.

1. The attached Test and Data and Performance Verification information was used to evaluate the equipment installation and operation.
2. The equipment is properly installed, has been tested by the manufacturer's authorized representative, and is operating satisfactorily in accordance with all requirements, except for items noted below.\*
3. Written operating and maintenance information has been presented to the Contractor, and gone over with him in detail.
4. Sufficient copies of all applicable operating and maintenance information, parts lists, lubrication checklists, and warranties have been furnished to the Contractor for insertion in the Operation and Maintenance Manuals.

Checked By: (Print or Type Name of Manufacturer's Representative)

(Address and Phone No. of Representative)

(Signature and Title of Representative)

(Date Checked)

Witnessed By: Signature and Title of Contractor Rep.)

\*Exceptions Noted At Time Of Check-Out (use additional page if necessary)

CONDUCTOR INSULATION RESISTANCE TEST MEMO

PROJECT NAME: \_\_\_\_\_

CONDUCTOR FROM \_\_\_\_\_ TO

SIZE

INSULATION TYPE

INSULATION VOLTAGE RATING

DATE \_\_\_\_\_ TIME

WEATHER CONDITIONS

TEST VOLTAGE (DC)

RANGE

MEGGER INSTRUMENT/SERIAL NUMBER

TESTING METHODOLOGY

INSULATION RESISTANCE MEASUREMENT (ACCEPTABLE MEASUREMENT NOT TO BE LESS THAN (1) MEGOHM):

PHASE A TO GROUND \_\_\_\_\_

PHASE B TO GROUND \_\_\_\_\_

PHASE C TO GROUND \_\_\_\_\_

NEUTRAL TO GROUND \_\_\_\_\_

ISOLATED GROUND TO GROUND \_\_\_\_\_

CONTRACTOR'S REPRESENTATIVE:

DATE:

OWNER'S REPRESENTATIVE:

DATE:

ENGINEER'S REPRESENTATIVE:

DATE:



DC HIGH VOLTAGE CABLE TEST REPORT

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

Location: \_\_\_\_\_

Description: \_\_\_\_\_

Rated Voltage: \_\_\_\_\_

TEST DATA

Set Leakage @ Test Voltage \_\_\_\_\_ ma Variac \_\_\_\_\_

Pri. Voltage \_\_\_\_\_

Sphere Gap \_\_\_\_\_ Inches

Duct Temp. \_\_\_\_\_ Ambient Temp. \_\_\_\_\_ Weather \_\_\_\_\_

Cable Status \_\_\_\_\_ 1 hour prior to test

---

---

Phase or Conductor	<u>A</u>	<u>B</u>	<u>C</u>	Remarks
Starting Time	<u>MA</u>	<u>MA</u>	<u>MA</u>	

- 0
- 15 sec.
- 30 sec.
- 45 sec.
- 1 min.
- 2 min.
- 3 min.
- 4 min.
- 5 min.

Final Test Voltage \_\_\_\_\_

Time Finish: \_\_\_\_\_

KV DC after 1 min.

Test Procedure \_\_\_\_\_ No. of Terminals \_\_\_\_\_

Joints \_\_\_\_\_

Witnessed by: \_\_\_\_\_ Performed by: \_\_\_\_\_

GROUND TEST INFORMATION

PROJECT NAME: \_\_\_\_\_

GROUND TYPE: \_\_\_\_\_

TEST BY: \_\_\_\_\_

DATE OF TEST: \_\_\_\_\_

GROUND LOCATION: \_\_\_\_\_

GROUND TYPE (Rod, Water pipe, etc.):

PRIOR TO CONNECTION TO SYSTEM

GROUND: \_\_\_\_\_ (OHMS)

AFTER CONNECTION TO SYSTEM

GROUND: \_\_\_\_\_ (OHMS)

WEATHER CONDITIONS (Wet/Dry):

SOIL CONDITIONS (Wet/Dry):

CONTRACTOR'S REPRESENTATIVE:

DATE:

ENGINEER'S REPRESENTATIVE:

DATE:

OWNER'S REPRESENTATIVE:

DATE:

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MOTOR TEST INFORMATION

PROJECT NAME:  
DESCRIPTION OF MOTOR:  
NAME OF CHECKER:  
DATE CHECKED:

(a) Name and identifying mark of motor (indicate at existing)

(b) Manufacturer

(c) Model Number

(d) Serial Number

(e) RPM

(f) Frame Size

(g) Code Letter

(h) Horsepower

(i) Nameplate Voltage and Phase

(j) Nameplate Amps

(k) Actual Voltage

(l) Actual Amps

(m) Starter Manufacturer

(n) Starter Size

(o) Heater Size, Catalog No. and Amp Rating

(p) Manufacturer of dual-element fuse

(q) Amp rating of fuse

(r) Power Factor

CONTRACTOR'S REPRESENTATIVE:

DATE:

SIGNATURE OF CHECKER:

DATE:

OWNER'S AUTHORIZED REPRESENTATIVE:

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PROGRESS AND RECORD DRAWING CERTIFICATION

NAME OF PROJECT:

DIVISION NUMBER AND NAME:

This is to certify that the attached marked-up design prints were marked as the items were installed at the site during construction, and that these prints represent as accurate "As-Builts" record of the work as actually installed. One copy will be turned over to the Owner at the instruction in Operation Conference. The duplicate copy is for the Engineer's files.

---

Name Of General Contractor

---

BY: Authorized Signature And Title

Date

Name Of Subcontractor

---

BY: Authorized Signature And Title

Date

SPARE PARTS CERTIFICATION MEMO

This form shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name:

Type of Spare Parts:

Specification Reference:

Quantity of Spare Parts:

Signature below by the contractor signifies that the spare parts required by the drawings and/or specifications have been turned over to the Owner.

---

(Name of General Contractor)

---

(Signature, Title, Date)

---

(Name of Subcontractor)

---

(Signature, Title, Date)

---

(Name of Owner)

---

(Signature, Title, Date)

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VOLTAGE AND AMPERAGE READINGS (TABULATED DATA)

PROJECT NAME: \_\_\_\_\_  
SWITCHGEAR/PANELBOARD

FULL LOAD AMPERAGE READINGS:

DATE \_\_\_\_\_  
TIME \_\_\_\_\_

PHASE A. \_\_\_\_\_  
B. \_\_\_\_\_  
C. \_\_\_\_\_  
N. \_\_\_\_\_  
GROUND \_\_\_\_\_

FULL LOAD VOLTAGE READINGS:

DATE  
TIME

PHASE A TO N \_\_\_\_\_ A TO B  
B TO N \_\_\_\_\_ A TO C  
C TO N \_\_\_\_\_ B TO C

VOLTAGE AT THE END OF THE LONGEST BRANCH

TYPE OF LOAD

NO LOAD VOLTAGE READINGS:

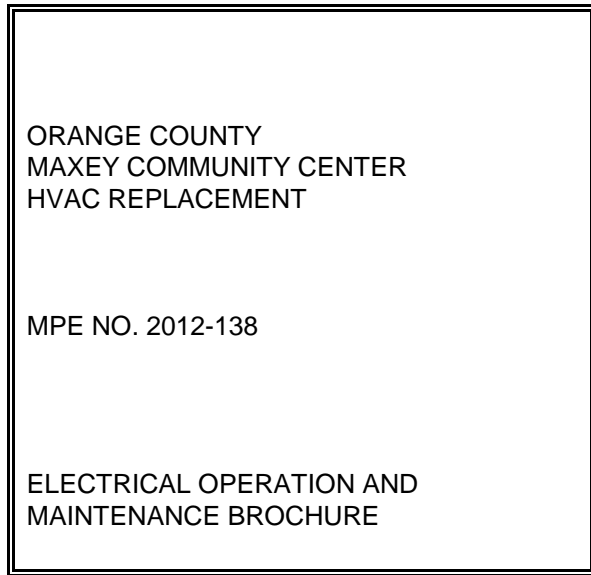
DATE  
TIME

PHASE A TO N \_\_\_\_\_ A TO B  
B TO N \_\_\_\_\_ A TO C  
C TO N \_\_\_\_\_ B TO C

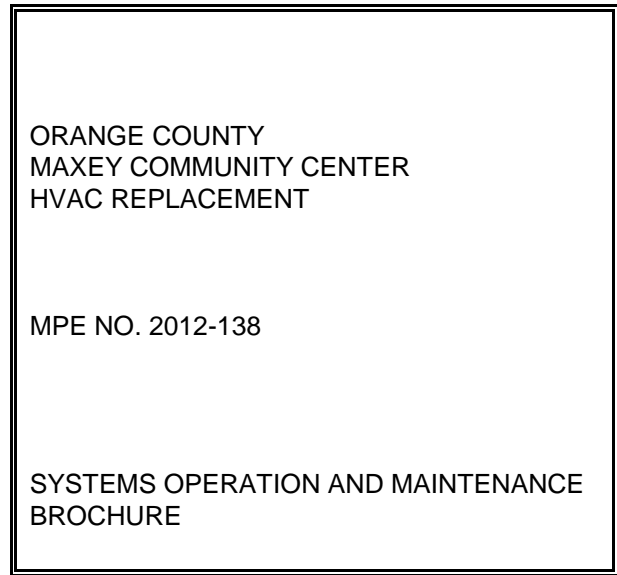
\_\_\_\_\_ ENGINEERS REPRESENTATIVE  
\_\_\_\_\_ OWNER'S AUTHORIZED REPRESENTATIVE  
\_\_\_\_\_ CONTRACTORS REPRESENTATIVE  
\_\_\_\_\_ DATE

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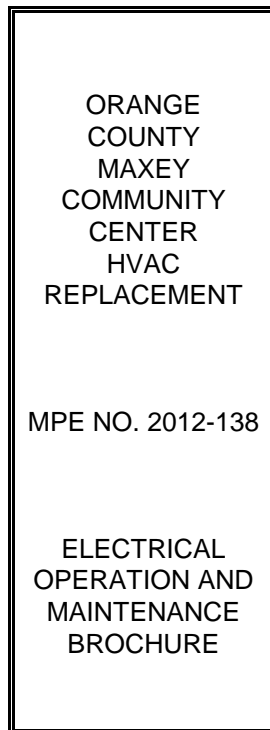
BINDER EXAMPLES FOR SUBMITTALS  
Insert In Vinyl Pockets (Front & Spline) 3-Ring Binder



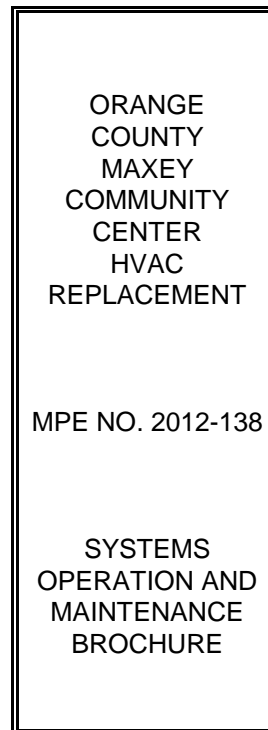
(Size To 8-1/2" x 11")



(Size To 8-1/2" x 11")



(Size To 11")



(Size To 11")

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SECTION 16111  
CONDUIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for electrical conduit.
- B. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
  - 1. Rigid Metal Conduit (RMC) NEC 344
  - 2. Intermediate Metal Conduit (IMC) NEC 342
  - 3. Flexible Metal Conduit (FMC) NEC 348
  - 4. Liquidtight Flexible Metal Conduit (LFMC) NEC 350
  - 5. Electrical Metallic Tubing (EMT) NEC 358
  - 6. Rigid Polyvinyl Chloride Conduit (Type PVC) NEC 352
  - 7. Fittings and Conduit Bodies
  - 8. Electrical Nonmetallic Tubing (ENT) NEC 362
  - 9. Flexible Nonmetallic Conduit

1.3 REFERENCES

- A. ANSI C80.1 Electrical Rigid Steel Conduit, Zinc Coated
- B. ANSI C80.3 Steel Electrical Metallic Tubing, Zinc Coated
- C. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- D. ANSI/NFPA 70 National Electrical Code
- E. NECA Standard Practice of Good Workmanship in Electrical Contracting
- F. NEMA RN 1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- G. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Conduit (EPC 40, EPC 80)
- H. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 DESIGN REQUIREMENTS

- A. Conduit Size: ANSI/NFPA 70. (See Drawings and this and other sections of these Specifications for additional requirements).
- B. Raceways and conduits shall begin at an acceptable enclosure and terminate only in another such enclosure except conduit/raceway stub-outs.
- C. A raceway shall be provided for all electrical power and lighting, and electrical systems unless specifically specified otherwise.

1.6 SUBMITTALS

- A. Submit catalog cut sheet showing brand of conduit to be used and showing that conduit is UL listed and labeled, and manufactured in the United States.



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- B. Submit catalog cut sheet on all types of conduit bodies and fittings.
- C. Product data shall be submitted for acceptance on:
  - 1. Conduits.
  - 2. Conduit straps, hangers and fittings.
  - 3. PVC solvent(s) and bending box.
  - 4. Fitting entering and leaving the ground or pavement.
- D. Submit UL listed fire and smoke stopping assemblies for each applicable application.
- E. Product data shall prove compliance with Specifications, National Electrical Code, National Board of Fire Underwriters, manufacturers' specifications and written installation data.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit record documents to accurately record actual routing of conduits larger than 1.25".

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, properly store and protect products at the site.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from sun, rain, corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

1.9 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All conduits shall bear UL label or seal and shall be manufactured in the United States.
- B. Conduit systems and all related fittings, boxes, supports, and hangers must meet all the requirements of national, state, Orange County/ local and other federal codes where applicable.

2.2 MINIMUM TRADE SIZE

- A. Homeruns: 3/4" C.
- B. Underground Branches: 3/4".
- C. Aboveground Branches: 1/2".
- D. Flexible and seal-tite metallic conduit 1/2" C (maximum 6' long).
- E. Rigid conduit - 3/4".
- F. Non-metallic conduit 3/4" C.
- G. EMT - 3/4".
- H. Flexible and seal-tite metallic conduit 1/2" C. (maximum 6' long).
- I. Homeruns and Underground Branches: 3/4" C.
- J. Aboveground Branches: 1/2" C.
- K. All Types: 1/2" C.

2.3 RIGID METAL CONDUIT

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- A. Comply with:
  - 1. ANSI C80.1.
  - 2. UL 6.
  - 3. NEC 344.
- B. Conduit material:
  - 1. Zinc coated or hot dipped galvanized steel.
- C. Fittings:
  - 1. Threaded.
  - 2. Insulated bushings shall be used on all rigid steel conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
  - 3. Hot dipped galvanized malleable iron or steel.
- D. Conduit Bodies:
  - 1. Comply with ANSI/NEMA FB 1.
  - 2. Threaded hubs.
  - 3. Hot-dipped galvanized malleable iron.

2.4 INTERMEDIATE METAL CONDUIT

- A. Comply with:
  - 1. UL Standard 1242.
  - 2. NEC 342.
- B. Conduit material: Zinc coated steel.
- C. Fittings:
  - 1. Threaded.
  - 2. Zinc plated malleable iron.
  - 3. Insulated bushings on terminations.
- D. Conduit bodies:
  - 1. Comply with ANSI/NEMA FB 1.
  - 2. Threaded hubs.
  - 3. Zinc plated or hot-dipped galvanized malleable iron.

2.5 FLEXIBLE METAL CONDUIT

- A. Comply with:
  - 1. NEC 348.
  - 2. ANSI/UL 1.
- B. Conduit material: Steel, interlocked.
- C. Fittings:
  - 1. ANSI/NEMA FB 1.
  - 2. ANSI/UL 514B.
  - 3. Malleable iron, zinc plated.
  - 4. Threaded rigid and IMC conduit to flexible conduit coupling.
  - 5. Direct flexible conduit bearing set screw type not acceptable.

2.6 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

- A. Comply with:
  - 1. NEC 350.
  - 2. ANSI/UL 360.

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- B. Conduit material:
  - 1. Flexible hot-dipped galvanized steel core, interlocked.
  - 2. Continuous copper ground built into core up to 1-1/4" size.
  - 3. Extruded polyvinyl gray jacket.
- C. Fittings:
  - 1. Threaded for IMC/rigid conduit connections.
  - 2. Accepted for hazardous locations where so installed.
  - 3. Provide sealing washer in wet/damp locations.
  - 4. Compression type.
  - 5. ANSI/NEMA FB 1.
  - 6. ANSI/UL 514B.
  - 7. Zinc plated malleable iron or steel.

2.7 ELECTRICAL METALLIC TUBING

- A. Comply with:
  - 1. UL 797.
  - 2. ANSI C80.3.
  - 3. NEC 358.
  - 4. ANSI/UL797.
- B. Conduit material: Galvanized steel tubing.
- C. Fittings:
  - 1. ANSI/NEMA FB 1.
  - 2. Compression Type
  - 3. Zinc plated malleable iron or steel.
  - 4. Concrete tight.
  - 5. T&B Series 5031/5030.

2.8 RIGID POLYVINYL CHLORIDE CONDUIT

- A. Comply with:
  - 1. NEMA TC 2.
  - 2. UL 651.
  - 3. NEC 352.
- B. Conduit material:
  - 1. Shall be high impact PVC, tensile strength 55 psi, flexural strength 11000 psi.
- C. Fittings:
  - 1. NEMA TC 3.
  - 2. UL 514.
- D. General:
  - 1. Shall be UL listed and identified.
  - 2. Shall conform to all national, state and local codes.
  - 3. Manufacturer shall have five years experience in manufacturing PVC conduits.

2.9 EXPANSION FITTINGS

- A. Expansion fittings shall be:
  - 1. UL listed, hot dipped galvanized inside and outside providing a 4" expansion chamber when used with rigid conduit, intermediate metal conduit and electrical metallic conduit, or:
  - 2. Be polyvinyl chloride and shall meet the requirements of and as specified elsewhere for non-metallic conduit and shall provide a 6" expansion chamber.
  - 3. Hot dipped galvanized expansion fitting shall be provided with an external braided grounding and bonding jumper with accepted clamps, UL listed for the application.
  - 4. Expansion fitting, UL listed for the application and in compliance with the National

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Electrical Code without the necessity of an external bonding jumper may be considered.  
Submit fitting with manufacturer's data and UL listing for acceptance prior to installation.

PART 3 - EXECUTION

3.1 LOCATION REQUIREMENTS

A. Underground Installations:

1. Use rigid non-metallic conduit (PVC) only unless local Authority Having Jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.
2. Use galvanized rigid conduit, or PVC encased in steel-reinforced concrete.
3. All conduits or elbows entering, or leaving the ground shall be rigid steel conduit coated with asphaltic paint.
4. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with NEC 300.5, except the minimum cover for any conduit shall be 30". Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.
5. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be re-coated after installation.
6. PVC runs over 150' in length shall utilize rigid steel 90 degree elbows at each riser and at each change in direction. Elbows shall be coated with black mastic or PVC coating. Bond all metal elbows per NEC 250.80 and NEC 300.5.
7. All underground service lateral raceways shall be protected as required by NEC 300.5, including requirements for installation of warning tape.

B. In Slab Above or on Grade:

1. Use coated rigid steel conduit, coated intermediate metal conduit (if accepted) or rigid non-metallic conduit.
2. Coating of metallic conduit to be black asphaltic or PVC.

C. Penetration of Slab:

1. Exposed Location:
  - a) Where penetrating a floor in an exposed location from underground or in slab, a black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
2. Concealed Location:
  - a) Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, rigid non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 48" above finished floor.
  - b) Where penetrating a floor in location other than that above use a black mastic coated or PVC coated galvanized rigid steel conduit.

D. Outdoor Location:

1. Above Grade:
  - a) Where penetrating the finished grade, black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
  - b) In general all exterior conduit runs shall be rigid and threaded connectors as specified elsewhere.
  - c) Electrical metallic tubing (thin wall) is permitted under roof, overhangs, etc. provided it is not subjected to physical damage and is not in direct contact or directly subject to exterior elements including sunlight.
  - d) Exterior conduits not on roof and not subject to damage (i.e. 6' above grade/floor or higher) may be rigid non-metallic PVC conduit as specified elsewhere. (Schedule 40 for low voltage Class II wiring, Schedule 80 for power wiring.)

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- e) Exterior conduits from grade level to 6' above grade may be rigid non-metallic Schedule 40 PVC for low voltage Class II wiring provided rigid metal conduit is used at transition from below grade to 12" above grade (due to weed eater damage, etc.).
- 2. Metal Canopies:
  - a) Conduit runs except for canopy lighting raceways are not to be run on (top or bottom) of metal canopies roof systems. All new conduit shown on or at these areas shall be run underground.
- 3. Roofs:
  - a) Conduit is not to be installed on roofs, without written authorization by A/E for specific conditions.
  - b) When accepted by written authorization conduit shall comply with the following:
    - 1. Be PVC coated rigid galvanized metal conduit.
    - 2. All fittings, etc. are to be PVC coated.
    - 3. Conduit shall be supported above roof at least 6" using accepted conduit supporting devices. Refer to applicable sections of specifications on roofing, etc.
    - 4. Supports to be fastened to roof using roofing adhesive or means as accepted by roofing contractor.
- E. Interior Dry Locations:
  - 1. Concealed: Use rigid metal conduit, intermediate metal conduit, electrical metallic tubing. Rigid non-metallic conduit may be used inside block walls up to first outlet to a maximum of 40" AFF except where prohibited by the NEC (places of assembly, etc.).
  - 2. Exposed: Use rigid metal conduit, intermediate metal conduit, electrical metallic tubing. EMT may only be used where not subject to damage, which is interpreted by this specification to be above 90" AFF.
  - 3. Concealed or exposed flexible conduit:
    - a) Concealed flexible steel conduit or seal tight flexible steel conduit in lengths not longer than 6' in length with a ground conductor installed in the conduit or an equipment ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Exposed flexible steel conduit or seal tight flexible steel conduit shall not exceed 2' in length, unless written authorization by A/E for specific conditions is granted.
- F. Interior Wet and Damp Locations:
  - 1. Use rigid galvanized steel or intermediate metal conduit.
- G. Concrete Columns or Poured in-place Concrete Wall Locations:
  - 1. Use rigid non-metallic conduit. Penetration shall be by accepted metal raceway (i.e. metal conduit as required elsewhere in these specifications).

3.2 ADDITIONAL REQUIREMENTS FOR RIGID STEEL CONDUIT

- A. Rigid steel conduit shall be cut and threaded with tools accepted for the purpose and by qualified personnel.
  - 1. Accepted pipe vise.
  - 2. Roller/bade type cutter or band saw.
  - 3. Reamer capable of completely removing all ridges or burrs left by the cutter. Reaming with pliers is not acceptable.
- B. Hangers shall be installed 8' apart.

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- C. Conduits stubbed through floor slabs, above grade and not contained inside walls, shall be rigid galvanized metallic conduit.

3.3 ADDITIONAL REQUIREMENTS FOR EMT

- A. Electrical metallic tubing (thin wall) may be installed inside buildings above ground floor where not subject to mechanical injury.
- B. All cuts shall be reamed smooth and free of sharp and abrasive areas by use of an accepted reamer.

3.4 ADDITIONAL REQUIREMENTS FOR FLEXIBLE STEEL CONDUIT AND SEAL-TITE FLEXIBLE STEEL CONDUIT

- A. Shall be properly grounded.
- B. Shall be installed with accepted fittings.

3.5 ADDITIONAL REQUIREMENTS FOR RIGID NON-METALLIC CONDUIT (PVC CONDUIT)

- A. Rigid non-metallic PVC conduit is not allowed anywhere inside building(s) except underground, in slab, in poured in place concrete, and in block wall up to first outlet box (if not over 40" AFF) if allowed by codes. Rigid non-metallic PVC conduit may be used exterior to building as stated elsewhere in these specifications.
- B. Join rigid non-metallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- C. Threads will not be permitted on rigid non-metallic PVC conduit and fittings, except for rigid steel to rigid non-metallic PVC couplings.
- D. Installation of rigid non-metallic PVC conduit shall be in accordance with manufacturer's recommendations.
- E. Rigid non-metallic PVC conduit shall not be used to support fixture or equipment.
- F. Field bends shall be made with accepted hotbox. Heating with flame and hand held dryers are prohibited.

3.6 SUPPORTS

- A. Arrange supports to prevent misalignment during wiring installation.
- B. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- C. Group related conduits; support using conduit rack. Construct rack using steel channel; (minimum 24" increase distance as required) provide space on each for 25 percent additional conduits.
- D. Fasten conduit supports to building structure and surfaces under provisions of Section 16190 Hangers and Supports.
- E. Do not support conduit with wire, metal banding material, or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach conduit to ceiling support wires.
- G. Conduits shall not be supported from ceiling grid supports, plumbing pipes, duct systems, heating or air conditioning pipes, or other building systems.
- H. Non-bolted conduit clamps, as manufactured Caddy Corp. are not accepted. Supporting conduit and boxes with wire is not accepted. All raceways except those from surface-mounted switches, outlet boxes or panels shall be supported with clamp fasteners with toggle bolt on hollow walls,

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and with lead expansion shields on masonry.

3.7 EXPANSION FITTINGS

- A. Provide expansion fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.
- B. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints; in each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit run above ground which is more than 100' long and interval between expansion fittings in such runs shall not be greater than 100'.

3.8 GROUNDING

- A. All raceways shall have a copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC codes.
- B. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on Drawings.
- C. Grounding conductors run with exterior/ underground feeders shall be bare only.
- D. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by accepted ground bushings.
- E. See other sections of these specifications for additional requirements.
- F. Grounding conductors (including lightning protection down conductors) run in metal conduit shall be bonded to metal conduit at both ends.

3.9 FIRE AND SMOKE STOPPING

- A. Contractor is to provide fire stopping and/or smoke stopping for all penetrations of existing (or new if applicable) fire or smoke barrier walls, chases, floors, etc. as required to maintain existing rating of floor, wall, chase, etc.
- B. Install conduit to preserve fire resistance rating of partitions and other elements.
- C. Install fireproofing material to maintain existing rating of floor, beams, etc. damaged or removed by renovation.
- D. Fire and smoke stopping material: A two-part silicone foam or a one-part putty, UL classified and FM accepted with flame spread of 0 and smoke development not to exceed 50 in accordance with ASTM E84. Material shall be suitable for penetration seals through fire-rated floors and walls when tested in accord with ASTM E119. Material shall not melt or soften at high temperatures, shall be suitable for direct outdoor and ultraviolet exposures, shall cure to give a tight compression fit, and shall not produce toxic fumes. Material, when heated, shall expand to fill and hold penetration closed where burn out of cable insulation or ATC tubing occurs.

3.10 VERTICAL RACEWAYS

- A. Cables in vertical raceways shall be supported per NEC 300-19. Provide and install supporting devices for cables, including any necessary accessible pullbox as required regardless if shown on Drawings or not. Provide and install access panels as required. Coordinate location of pull box and access panel with architect prior to installation. This includes empty raceways for future use.

3.11 GENERAL

- A. Install conduit in accordance with NECA Standard Practice of Good Workmanship in Electrical

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Contracting. Contractor shall layout all work prior to rough-in.

- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange conduit to maintain headroom and present neat appearance.
- D. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.
- E. Route conduit in and under slab from point-to-point.
- F. Do not cross conduits in slab.
- G. Maintain adequate clearance between conduit and piping.
- H. Maintain 12" clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
- I. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- J. Bring conduit to shoulder of fittings; fasten securely.
- K. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- L. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2" size.
- M. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- N. Provide and install pullboxes, junction boxes, fire barrier at fire rated walls etc., as required by NEC 300, whether shown on Drawings or not.
- O. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have conductors furnished under this Division of the specifications. Pullcord must be fastened to prevent accidental removal. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- P. Grounding and bonding of conduit under provisions of Section 16170 Grounding and Bonding .
- Q. Identify conduit under provisions of Section 16195 Identification for Electrical Systems.
- R. Install all conduits concealed from view unless specifically shown otherwise on Drawings
- S. Rigid steel box connections shall be made with double locknuts and bushings.
- T. All raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- U. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- V. All raceways shall be run from outlet to outlet as shown on the Drawings, unless permission is granted to alter arrangement shown. If permission is granted arrangement shall be marked on field set of Drawings as previously specified.
- W. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6" round x 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.
- X. All conduit stubbed above floor shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel. Spare conduit stubs shall be capped with a UL listed and accepted



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cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare."

- Y. All connections to motors or other vibrating equipment including transformers or at other locations where required shall be made with not less than 12" of flexible liquid-tight steel conduit, with nylon insulated throat connectors and wire mesh grip fittings (manufactured by Thomas & Betts or accepted equal) at both terminations of conduit. Use angle connectors wherever necessary to relieve angle strain on flex conduit.
- Z. Provide conduit seal-offs wherever conduit crosses obvious temperature changes (i.e. from inside to outside of coolers, freezers, etc.).
- AA. Route conduit through roof openings for piping and ductwork or through suitable roof flashing or boot. Coordinate location with roofing installation specified under other sections of these Specifications.
- BB. All raceways shall be run in neat and workmanlike manner and shall be properly in accordance with latest edition of NEC with accepted conduit clamps, hanger rods and structural fasteners.
- CC. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.
- DD. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

END OF SECTION

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SECTION 16123  
BUILDING WIRE AND CABLE

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 requirements for provision and installation of building wire and cable.
- B. Provide all equipment, labor, material, accessories, and mounting hardware to properly install all conductors and cables rated 600 volts and less for a complete and operating system for the following:
  - 1. Building wire and cable.
  - 2. Wiring connectors and connections.
- C. No aluminum wiring shall be permitted.
- D. All sizes shall be given in American Wire Gauge (AWG) or in thousand circular mils (MCM/kcmil).

1.3 REFERENCES

- A. ANSI/NFPA 70 National Electrical Code
- B. NEC 330
- C. UL 486A-486B

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Product Data: Submit catalog cut sheet showing, type and UL listing of each type of conductor, connector and termination.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.7 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.8 COORDINATION

- A. Determine required separation between cable and other work.
- B. Determine cable routing to avoid interference with other work.

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PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: ANSI/NFPA 70, Type THHN/THWN and XHHW.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Conductors #10 AWG or #12 AWG shall be 600 volt type THWN/THHN unless noted otherwise, rated 90 degrees C. dry, 75 degrees C wet.
- C. Conductors #8 AWG and larger shall be Type THWN-2/THHN unless noted otherwise, rated 90 degrees C, wet or dry.
- D. Use solid conductor for feeders and branch circuits 10 AWG and smaller (except for control circuits).
- E. Use conductor no smaller than 12 AWG for power and lighting circuits.
- F. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- G. All conductors shall be installed in raceway.
- H. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit, unless noted otherwise on the Drawings or in these Specifications.
- I. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).
- J. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.
- K. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

3.2 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire has been completed.

3.3 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.4 WIRING METHODS

- A. Use only building wire type (THHN/THWN for #10 and #12 and THHN/THWN-2 for #8 and larger) insulation in raceway unless noted otherwise.
- B. Wiring in vicinity of heat producing equipment; use only XHHW insulation in raceway.
- C. Conductors installed within fluorescent fixture channels shall be Type THHN or XHHW rated 90 degrees C dry. Conductors for all other light fixtures shall have temperature ratings as required to meet the UL listing of the fixture; however, in no case shall the temperature rating be less

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than 90 degrees C. Remove incorrect insulation types in new work.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 16195 Identification for Electrical Systems.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.
- C. Identify neutrals with its associated circuit number(s).

3.6 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of the General Requirements of the Contract Documents and Section 16090 Tests and Performance Verification of Electrical System.
- B. Inspect wire for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor.

3.7 VERTICAL RISERS

- A. Provide vertical cable riser supports per NEC 300. 19. Cable supports shall be O-Z/Gedney Type "S" or equal. These shall be located in accessible pullboxes of adequate size. Provide for adequate structural connection of cable supports to pullbox, which will transfer cable weight to building.

3.8 PULLING

- A. No wire shall be pulled until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.
- B. Mechanical pulling devices shall not be used on conductors sized #8 and smaller. Pulling means which might damage the raceway shall not be used.
- C. Use only powdered soapstone or other pulling lubricant acceptable to the A/E. Compound or lubricant shall not cause the conductor or insulation to deteriorate.
- D. All conductors to be installed in a common raceway shall be pulled together. The manufacturer's recommended pulling tensions shall not be exceeded.
- E. Bending radius of insulated wire or cable shall not be less than the minimum recommended by the manufacturer.
- F. Where communications type conductors are installed, special requirements shall apply as outlined under that specific system detail specifications.

3.9 CONTROL AND SIGNAL CIRCUITS

- A. For control and signal circuits above 50 VAC, conductors shall be #14 AWG minimum size Type XHHW or THWN-THHN as permitted by NFPA 70 within voltage drop limits, increased to #12 AWG as necessary for proper operation.
- B. For control and signal circuits 50 VAC and below, conductors, at the Contractor's option, may be #16 AWG, 300 volt rated, PVC insulated, except where specifically noted otherwise in the Contract Documents.
- C. Conductor insulation for fire alarm systems shall be as accepted by Code Inspection Authority only. Wire acceptance by the A/E shall not supersede this final acceptance for conditions of this specific project.
- D. Install circuit conductors in conduit.

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- E. Circuit conductors to be stranded.

3.10 COLOR CODING

- A. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel.
- B. Unless otherwise accepted or required by A/E to match existing, color-code shall be as follows:  
Neutrals: 120/208V system white; 277/480V system natural gray  
Ground Wire: green, bare  
Isolated Ground Wire: green with yellow stripes  
120/208V: Phase A black, Phase B red, Phase C blue  
277/480V: Phase A brown, Phase B orange, Phase C yellow
- C. All switchlegs, other voltage system wiring, control and interlock wiring, shall be color-coded other than those noted above.

3.11 TAPS/SPLICES/CONNECTORS/TERMINATIONS

- A. Clean conductor surfaces before installing lugs and connectors.
- B. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- C. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without written acceptance of engineer).
- D. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum. Pull conductors through to equipment, terminal cabinets, and devices.
- E. No splices shall be made in junction box or outlet boxes (wire No. 8 and larger) without written acceptance of Engineer.
- F. No splices shall be made in communications outlet boxes, pull boxes or wireways (i.e., fire alarm, computer, telephone, intercom, sound system, etc.) without written acceptance of Engineer. Pull cables through to equipment cabinets, terminal cabinets and devices.
- G. Allow adequate conductor lengths in all junction boxes, pull boxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length. This requirement shall include the Contractor to provide sleeve type vertical cable supports in vertical raceway installations provided in pullboxes at proper vertical spacings.
- H. A calibrated torque wrench shall be used for all bolt tightening.
- I. Interior Locations:
  - 1. All (non-electronic systems) copper taps and splices in No. 8 or smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire.
- J. Exterior Locations:
  - 1. Make splices, taps and terminations above grade in splice or termination cabinets. Do not splice any cable in ground or below finished grade.
  - 2. All taps and splices shall be made with compression type connectors and covered with

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Raychem heavywall cable sleeves (type CRSM-CT, WCSM or MCK) with type "S" sealant coating with sleeve kits as per manufacturer's installation instructions or be terminated/connected to terminal strips in above grade terminal boxes suitable for use.

3. Provide and install above grade termination cabinets sized to meet applicable codes and standards, where required for splicing.

END OF SECTION

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SECTION 16131  
OUTLET BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes wall and ceiling outlet boxes (and/or small junction/pullboxes).
- B. Provide and install all outlet boxes (flush or surface) complete with all accessories as required to facilitate installation of electrical system and as required by the NEC.

1.3 REFERENCES

- A. ANSI/NEMA FB 1 Fittings Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- B. ANSI/NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- C. ANSI/NFPA 70 National Electrical Code
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Submit catalog cut sheets/product data on:
  - 1. Surface cast boxes.
- B. For pullboxes and junction boxes not covered in Section 16133 Pull and Junction Boxes, submit product data showing dimensions, covers, and construction.

1.6 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of outlets in offices and work areas prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All boxes and fittings shall be labeled by Underwriters Laboratories.
- B. Provide box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, outlet boxes, and corrosion-resistant knockout closures compatible with outlet boxes being used and meeting requirements of individual wiring situations.
- C. All boxes shall be of the size and shape required by NFPA 70 for their respective locations.
- D. Boxes shall be of such form and dimensions as to be adapted to the specific use and location,

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- E. Handy boxes shall not be used.
- F. Outlet boxes to be one-piece.
- G. 4" x 4" boxes and 4 11/16" x 4 11/16" boxes used as junction boxes shall be one piece.

2.2 SHEET METAL OUTLET BOXES ANSI/NEMA OS 1, GALVANIZED STEEL:

- A. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2" male fixture studs where required.
- B. Concrete Ceiling Boxes: Concrete type.
- C. Interior flush outlet boxes shall be galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices. T&B, Steel City, Raco or accepted substitution.
- D. Ceiling outlet boxes shall be 4" octagonal or 4" square X 1-1/2" deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them.
- E. Switch, wall receptacle, telephone and other recessed wall outlet boxes in drywall shall be 4" square X 1-1/2" deep. For recessing in exposed masonry, provide one piece 4" square x 1-1/2" deep wall boxes with appropriate 4" square cut tile wall covers Steel City series #52-C-49/52-C-52 or accepted substitution. For recessing in furred-out block walls, provide 4" square box with required extension for block depth and required extension for drywall depth.

2.3 CAST BOXES NEMA FB 1:

- A. Interior surface outlet boxes and conduit bodies installed from 0" AFF to 90" AFF (including fire alarm device backbox) shall be the heavy cast aluminum or iron with external threaded hubs for power devices and threaded parts for low voltage devices; Appleton, Crouse Hinds or accepted substitution. Trim rings shall also be of one-piece construction.
- B. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast metal suited to each application and having threaded conduit hubs, cast metal faceplate with spring-hinged waterproof cap suitably configured, gasket, and corrosion-proof fasteners.
- C. Boxes to be Type FD unless otherwise noted on drawings.
- D. Freestanding cast boxes are to be type FSY (with flange). Other cast zinc boxes are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
- D. Install boxes to preserve fire resistance rating of partitions and other elements.
- E. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- F. Use flush mounting outlet boxes in finished areas.



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- G. Do not install flush mounting boxes back-to-back in walls; provide minimum 6" separation. Provide minimum 24" separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Support all outlet boxes from structure with minimum of one 3/8" all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two all-thread rod hangers, minimum.
- L. Do not fasten boxes to ceiling support wires.
- M. Support boxes independently of conduit.
- N. Use gang box where more than one device is mounted together. Do not use sectional box.
- O. Use gang box with plaster ring for single device outlets.
- P. Use cast outlet box in exterior locations and wet locations.
- Q. Comply with applicable portions of the NECA National Electrical Installation Standards.
- R. Install outlets in the locations shown on the drawings; however prior to rough-in, the Owner shall have the right to make slight changes in locations to reflect room furniture layouts.
- S. The Contractor shall coordinate his work with that of the General Contractor so that each electrical box is the type suitable for the wall or ceiling construction provided and suitable fireproofing is inbuilt into fire rated walls.
- T. The Contractor shall relocate electrical boxes as required so that once installed, electrical devices will be symmetrically located with respect to the room layout.
- U. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete.
- V. For locations exposed to weather or moisture (interior or exterior), provide weatherproof boxes and accessories.
- W. As a minimum, provide pull boxes in all raceways over 150'. The pull box shall be located near the midpoint of the raceway length.
- X. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.
- Y. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.
- Z. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.
- AA. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
- BB. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or accepted for the purpose. Add-a-Depth rings or switch box extension rings (Steel City #SBEX) are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted.

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Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8" of finish wall surface.

- CC. Outlet boxes mounted in metal stud walls are to be supported to studs with two screws inside of outlet box to a horizontal stud brace between vertical studs or one side of outlet box supported to stud with opposite side mounted to section of stud or device to prevent movement of outlet box after wall is finished.
- DD. All outlet boxes that do not receive devices in this Contract are to have blank plates installed matching wiring device plates.
- EE. Mount Height:
  - 1. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural Drawings and Shop Drawings for installing:

Switches	4'-0" AFF to top
Receptacles	1'-4" AFF to bottom
Lighting Panels	6'-6" AFF to centerline of highest breaker/fuse
Phone outlets	1'-4" AFF to bottom
Intercom Call-in button/handsets	4'-0" AFF to top
Fire Alarm Pull Stations	4'-0" AFF to top
Fire Alarm Strobe Lights	80" AFF to bottom
Thermostats	4'-0" AFF to top
Space Sensors	4'-0" AFF to top
  - 2. Bottoms of outlets above countertops or base cabinets shall be minimum 2" above countertop or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Division to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on Architectural Drawings, prior to rough-in, regardless of height shown on Division 16 Drawings.
  - 3. Height of wall-mounted fixtures shall be as shown on the drawings or as required by Architectural Drawings and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate installation of outlet box for products furnished under all Sections of these Specifications.
- B. Coordinate locations and sizes of required access doors with applicable Sections in these Specifications.
- C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.3 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closure in unused box opening.

END OF SECTION

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SECTION 16133  
PULL AND JUNCTION BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide and install pull and junction boxes as shown on Drawings or as required by the NEC.
- B. Provide and install pull and junction boxes wherever required for a complete and operating distribution system whether shown on Drawings or not.
- C. Where outlet boxes are used for pull and/or junction boxes, they shall meet the requirements of Section 16131 Outlet Boxes.

1.3 REFERENCES

- A. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- B. ANSI/NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- C. ANSI/NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- D. ANSI/NFPA 70 National Electrical Code
- E. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Submit actual shop drawings on all pull boxes showing.
  - 1. Covers.
  - 2. Dimensions - inside and out.
  - 3. Rating of concrete or gauge of metal.
  - 4. Manufacturer.

1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of pull and junction boxes.

1.7 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of pull and junction boxes prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose and to maintain required access.

PART 2 - PRODUCTS

2.1 GENERAL

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- A. Dimensions of pull and junction boxes shall meet dimensions shown on Drawings or dimensions required by NEC, whichever is largest.
- B. Pull and junction boxes shall meet all requirements of UL and NEC.
- C. Small pull boxes (i.e. 4" x 4") shall meet the requirements of these Specifications for outlet boxes as a minimum.
- D. All boxes (above ground) of 100 cubic inches or more shall be constructed of 14 gauge steel with hot dip galvanized coating.

2.2 SHEET METAL BOXES

- A. NEMA OS 1, galvanized steel.
- B. Box to be fully weatherproof and watertight where installed outside.

2.3 IN-GROUND PULL BOXES

- A. Material: Precast concrete, or composite.
- B. Bottom: Open with 6" of gravel for drainage.
- C. Cover: Meet Florida Dept. of Transportation requirements for installed location, (pedestrian, heavy traffic, light traffic).
- D. Solid sides constructed to facilitate conduit entries.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install per NEC
- B. Install electrical boxes as shown on Drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
- F. Install boxes to preserve fire resistance rating of partitions and other elements.
- G. Align adjacent wall-mounted boxes with each other.
- H. Use flush mounting boxes in finished areas.
- I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6" separation. Provide minimum 24" separation in acoustic rated walls.
- J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- L. Pull and junction boxes larger than 25 square inches shall be supported with two 3/8" all-thread rod hangers minimum.
- M. Install all labels and identification as required by the NEC and applicable sections of these Specifications.
- N. Pull and junction boxes used for systems (Sections 16700-16799) larger than 25 square inches shall be hinged cover type.
- O. Do not fasten boxes to ceiling support wires.

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- P. Support boxes independently of conduit.
- Q. Large Pull Boxes:
  - 1. Boxes larger than 100 cubic inches in volume or 12" in any dimension.
    - a) Interior dry locations per NEC with screw covers.
  - 2. Other locations use hinged enclosure under provisions of Section 16160 Cabinets and Enclosures.
- R. Boxes Installed Outdoors: All boxes installed outdoors to be NEMA 4, fully weatherproof and watertight.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations and sizes of required access doors with applicable sections in these Specifications.
- B. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

3.3 ADJUSTING

- A. Install knockout closure in unused box opening.

END OF SECTION

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SECTION 16141  
WIRING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
  - 1. Wall switches.
  - 2. Receptacles.
  - 3. Device plates and decorative box covers.

1.3 REFERENCES

- A. NEMA WD 1 General Requirements for Wiring Devices
- B. NEMA WD 6 Wiring Devices Dimensional Specifications

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
  - 1. Submit product data on all types of wiring devices including plates and engraving.
- B. Manufacturer's Instructions:
  - 1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
  - 2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.7 EXTRA MATERIALS

- A. Provide a minimum of two screwdrivers of each type of tamper proof screw used on project.
- B. Turn over to Owner and submit Spare Parts Certification receipt. (See Section 16098 Operation and Maintenance Manuals).

PART 2 - PRODUCTS

2.1 GENERAL

- A. All devices shall be Specification Grade as minimum.
- B. General purpose wiring devices shall meet NEMA standard WD-1, Wiring Devices, General

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Purpose. Special purpose devices shall conform to the requirements of NEMA standard WD-5, Wiring Devices, Special Purpose.

- C. All wiring devices shall bear UL labels.
- D. All devices of one type (i.e. all snap switches, all duplex receptacles, etc.) shall be by the same manufacturer. Hazardous Location and Special Purpose Devices may not be available from the same manufacturer; this shall constitute the only exception to this requirement of single-source.
- E. Corrosion resistant devices shall be as specified for normal usage, and fabricated of yellow color melamine plastic. Where "Weatherproof" type is indicated for exterior or wet locations, provide matching self-closing cover with gasketed seals at plate/wall junctions and for cover.
- F. Provide factory packaged wiring devices having high impact strength molded plastic bodies.
- G. Except where specifically required in these Specifications, use of interchangeable type or combination switch-receptacle-pilot devices is not acceptable and shall be removed.

## 2.2 RECEPTACLES

- A. General:
  - 1. All receptacles shall be of standard NEMA configuration, as indicated on the Drawings, and shall comply with the respective ANSI C73 series standard for the NEMA configuration. Color to match plates unless specifically noted otherwise in specifications and/or on Drawings.
  - 2. Duplex receptacles shall have integral UL listed self-grounding clips. Similar, single receptacles shall be provided for plug-in connections of industrial fluorescent light fixtures on the same switching circuit. Receptacle face to be impact resistant nylon.
  - 3. Special purpose receptacles for specific equipment shall be grounding types, having the number of poles, voltage and ampere ratings, and NEMA configurations required by the equipment. For each special purpose receptacle, provide an identical mating plug equipped with cord grip, secured to cord.
  - 4. Duplex receptacles shall have back and side wired screw pressure terminals.
- B. Description: NEMA WD 1; heavy-duty general use receptacle.
- C. Configuration: NEMA WD 6; heavy-duty, general use type as specified and indicated.
- D. Convenience Receptacle: Type 5-20.
- E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
- F. Manufacturers:
  - 1. See Drawings.

## 2.3 COVER PLATES

- A. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.
- B. Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel having a nominal thickness of .04" and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.
- C. Where so directed by the A/E (either by Contract Documents or direction after the bid) substitute nylon plates of quality as specified below, without increase in Contract Price. Coordinate prior to

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securing plates for project. Where nylon cover plates are required in finished interior spaces, these shall be fabricated of either non-combustible mar-proof high impact resistant fiberglass or nylon reinforced thermosetting material or nylon, having a minimum thickness of .10", with smooth finish. Screws securing the plates shall have flush (when installed) heads of color to match plates. Nylon cover plates shall conform to Federal Specification QP-455A and all other NEC, UL and NEMA requirements. Where required by A/E nylon plates shall be fitted with nylon screws for totally nonmetallic surface installation.

- D. Cover plates for switches located in corrosive atmospheres (where vaporproof is not indicated) shall be equal to Hubbell #17CM81/#17CM82/#17CM83/#17CM84 one piece neoprene with matching presswitch.
- E. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed..
- F. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the Drawings. Metallic plates and nylon plates in ivory, beige, gray, and white shall be engraved with black fill. Red, brown, and black nylon plates shall be engraved with white fill.
- G. Unless specifically noted otherwise in Specifications or on Drawings, all outlets for telephone and other communications and data systems shall be provided with standard size one-piece cover plates having a minimum 3/4" diameter bushed hole in the center unless specifically noted otherwise in Specifications and/or on Drawings. Where telephone conductors are installed, plates shall contain telephone type, polarized plug-in receptacles.
- H. All device plates (including systems device plates and trims) located in secure areas such as cells, dayrooms, holding rooms, recreation areas, etc., shall have security wall plates (minimum 10 gauge) with minimum 12 gauge galvanized steel backplate. Plates shall have TORX counter pin reject type tamperproof screws.
- I. All device plates (including systems device plates and trims) and blank plates located in all secure areas shall be mounted with tamper proof screws, unless otherwise noted.

#### 2.4 COLOR

- A. Wiring devices connected to normal power and located in unfinished spaces shall be grey color. Devices connected to normal power and located in finished interior spaces shall be of color selected by Architect from the following list of standard colors: ivory, beige, gray, white, brown, black.
- B. Cover plates for devices connected to normal power and located in finished interior spaces shall be of color selected by Architect from the above list of standard colors or #302 stainless steel.
- C. All devices and coverplates in paneled walls shall have finish to match paneling.
- D. Contractor shall modify any given catalog numbers as required to procure devices and plates of the proper color.

### PART 3- EXECUTION

#### 3.1 EXAMINATION

- A. Verify conditions under provisions of Division 1 General Requirements and any other applicable supplemental requirements/conditions.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify floor boxes are adjusted properly.
- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring



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devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on bottom.
- E. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- F. Electrical boxes shall be cleaned and completely free of any debris, dust, etc. prior to the installation of wiring devices.
- G. Where two or more switches or receptacles are to be installed adjacent to one another, provide a multi-gang box and combination multi-gang coverplate. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems.
- H. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch.
- I. In finished areas provide same type of plate for all surface mounted devices as for recessed mounted devices.
- J. In any room where new and existing construction is present, all receptacles, switches, and coverplates which are existing to remain shall be changed as required to match new work.
- K. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.
- L. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.
- M. All wiring devices, relays, contactors, pushbuttons, selector switches, pilot lights, etc. shall be installed in approved enclosures rated for the appropriate NEMA classified environment.
- N. All devices shall be installed so that only one wire is connected to each terminal.
- O. Once construction is substantially completed, replace all damaged, burned, or scorched wiring devices.
- P. Receptacles shown to be floor mounted shall be installed in floor boxes (with coverplates) which are approved for this use.
- Q. Connect wiring devices by wrapping conductor around screw terminal.
- R. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- S. Install protective rings and split nozzle on active flush cover service fittings.
- T. Install local room area wall switches at door locations on the lock side of the door approximately four inches from the jamb. Where locations shown on the Drawings are in question, provide written request for information to A/E prior to rough-in.

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3.4 NEUTRAL CONDUCTOR CONNECTIONS

- A. Each receptacle's "in" and "out" phase and neutral conductors shall have an additional conductor for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under other Sections of these Specifications to obtain mounting heights specified and indicated on Drawings.

3.6 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

END OF SECTION

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SECTION 16170  
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Section, apply to this Section.

1.2 SUMMARY

- A. Section Includes
  - 1. Grounding electrodes and conductors.
  - 2. Equipment grounding conductors.
  - 3. Bonding.
  - 4. Counterpoise System.
- B. Provide all labor, materials, and equipment necessary to properly install a grounding system conductor in all new branch wiring and feeder installations, which shall be in full compliance with all applicable codes as accepted by the Authorities Having Jurisdiction. The secondary distribution system shall include a grounding conductor in all raceways in addition to the return path of the metallic conduit.
- C. In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated or bare copper system grounding conductor in accordance with specific rules of NEC 250, and state codes. Bonding conductor through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.
- D. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors that run with feeders in PVC conduit outside of building(s) shall be bare only.
- E. Provide and install all grounding and bonding as required by the National Electrical Code (NEC) including but not limited to NEC 250.

1.3 REFERENCES

- A. ANSI/NFPA 70 National Electrical Code
- B. NFPA 780 Standard for the Installation of Lightning Protection Systems
- C. UL 467 Grounding and Bonding Equipment

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Submit catalog cut sheets/product data on:
  - 1. Ground rods and couplings.
  - 2. Mechanical connectors.

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3. Ground wells.
  4. Ground bus bars and associated components.
  5. Ground ring conductor.
  6. Counterpoise conductor.
  7. Exothermic welding materials and molds.
  8. Testing equipment and procedures.
- B. Product data shall prove compliance with specifications, National Electrical Code, manufacturers' specifications, and written installation data.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit record documents to accurately record actual locations of grounding electrodes.
- B. Submit test results of each ground rod. See Section 16090 Tests and Performance Verification of Electrical System.

PART 2- PRODUCTS

2.1 MECHANICAL CONNECTORS

- A. All grounding connectors shall be in accordance with UL 467 and UL listed for use with rods, conductors, reinforcing bars, etc., as appropriate.
- B. Connectors and devices used in the grounding systems shall be fabricated of copper or bronze materials, and properly applied for their intended use. Specified items of designated manufacturers indicate required criteria. Equal products may be provided if approved. All connectors and devices shall be compatible with the surfaces being bonded and shall not cause galvanic corrosion by dissimilar metals. Materials in items not listed herein shall be of equal quality to the following specified items:
  1. Lugs: Substantial construction, of cast copper or cast bronze, with "ground" (micro-flat) surfaces, twin clamp, two-hole tongue, equal to Burndy QQA Series or T&B equal. Lightweight and "competitive" devices shall be rejected.
  2. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or equal.
  3. Piping Clamps: Burndy GAR-TC Series with two hole compression terminal or T&B equal.
  4. Grounding Screw and Pigtail: Raco No. 983 or equal.
  5. Building Structural Steel, Existing: Thompson 701 Series heavy duty bronze "C" clamp with two-bolt vise-grip cable clamp.
- C. Mechanical lugs or wire terminals shall be used to bond ground wires together or to junction boxes and panel cabinets and shall be manufactured by Anderson, Buchanan, Thomas and Betts Co., or Burndy.

2.2 WIRE

- A. Material: Stranded copper.
- B. Size: Size to meet NFPA 70 requirements as a minimum, increase size if called for on Drawings, in these specifications, or as required for voltage drop.
- C. Insulated THWN (or bare as noted elsewhere).

2.3 GROUNDING WELL COMPONENTS

- A. Grass Non-Traffic Areas:
  1. Well: Sleeve 18" long, diameter 12" (minimum).

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2. Well Cover: High-density plastic, composolite, or cast iron with legend "GROUND" embossed on cover.
  3. Material: Structural Plastic, composolite, or concrete.
  4. Manufacturer: Carson 2200 Series or equal by Quazite.
  5. Increase depth, diameter or size as required to provide proper access at installed location.
- B. Paving and Low Traffic Areas:
1. Well: Minimum 12" long by 12" wide by 18" deep with open bottom.
  2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
  3. Material: Composolite.
  4. Manufacturer: Quazite.
  5. Increase depth, diameter or size as required to provide proper access at installed location.
- 2.4 GROUNDING BARS/GROUND BUS (INCLUDING SYSTEMS GROUND BUS/BARS AND GROUND BUS BARS)
- A. Ground bars shall be copper of the size and description as shown on the Drawings. If not sized on Drawings, bus bar shall be minimum 1/4" x 2" bus grade copper, spaced from wall on insulating 2" polyester molded insulator standoff/supports, and be 12" or greater minimum overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4" high and 24" long.
  - B. Provide bolt-tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2" on center spacing. Lugs to be manufactured by Burndy or T&B.
  - C. Standoff supports to be 2" polyester as manufactured by Glastic No. 2015-4C.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding electrodes conductor, bonding conductors, ground rods, etc. with all required accessories.
- C. Grounding shall meet (or exceed as required to meet these specifications) all the requirements of the NEC, the NFPA, and applicable standards of IEEE.
- D. Where there is a conflict between these specifications and the above applicable codes/standards, or between this section of these specifications and other sections, then the most stringent or excessive requirement shall govern. Where there is an omission of a code/standard requirement in these specifications then the code/standard requirements shall be complied with.
- E. Requirement in these specifications to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles, etc.

3.2 GROUNDING ELECTRODES

- A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by braising or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on Drawings.

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- B. Each rod shall be die stamped with identification of manufacturer and rod length.
- C. Install rod electrodes at locations indicated and/or as called for in these Specifications.
- D. Ground Resistance:
  - 1. Main Electrical Service (to each building) and Generator Locations:
    - a) Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.
  - 2. Other Locations:
    - a) Resistance to ground of all non-current carrying metal parts shall not exceed 5 ohms measured at motors, panels, buses, cabinets, equipment racks, light poles, transformers, and other equipment.
  - 3. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two or more ground rod electrodes then the resistance specified above shall be the maximum resistance with two or more rods connected together but not connected to the grounding electrode conductor.
- E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor). Depending on soil condition, etc. of ground rod locations, it has been found that the ground rod lengths required to achieve the specified resistance may range from the minimum specified length to up to 80' or more in length.
- F. Provide grounding well with cover at each rod location. Install grounding well top flush with finished grade.
- G. Verify that final backfill and compaction has been completed before driving rod electrodes.
- H. Install ground rods not less than 1' below grade level and not less than 2' from structure foundation.

### 3.3 GROUNDING ELECTRODE CONDUCTOR

- A. Conductor shall be sized to meet (or exceed as required to meet these Specifications and/or Drawings) the requirements of NEC 250.

### 3.4 EQUIPMENT GROUNDING CONDUCTORS

- A. Grounding conductors shall be provided with every circuit to meet (or exceed as required to meet these Specifications and/or Drawings) the requirements of NEC 250.
- B. At every voltage level, new portions of the electrical power distribution system shall be grounded with a dedicated copper conductor, which extends from termination back to power source in supply panelboard.
- C. Provide separate, insulated (bare if with feeder in PVC conduit outside of building(s)) conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- D. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed as required to meet these specifications and/or drawings) the requirements of NEC 250. Conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the Grounding Bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. The ground shall be in addition to the metallic raceway and shall be properly connected thereto, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.

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- E. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.
- F. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.
- G. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.
- H. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with accepted connectors regardless of conduit size or type. This shall include Food Service equipment, Laundry equipment, and all other "Equipment By Owner" to which an electric conduit is provided under this Division.

3.5 MAIN ELECTRICAL SERVICE

- A. Existing Buildings:
  - 1. Contractor shall verify that each building's electrical service is properly grounded as required by the NEC.
  - 2. Provide and install electrical service grounding at each building as called for herein for all existing services that do not comply with the grounding specified above.
  - 3. Supplement existing electrical service grounding at each building as required to comply with all requirements in these specifications.
- B. Complete installation shall meet and exceed the requirements of the NEC 250.
- C. Artificial electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.
- D. Provide and bond to all of the following:
  - 1. Ground rods.
  - 2. Metal water pipe (interior and exterior to building).
  - 3. Building metal frame, structural steel and/or reinforced structural concrete.
  - 4. All piping entering or leaving all buildings (including chilled water piping).
  - 5. Lightning protection system.

3.6 LIGHTNING PROTECTION SYSTEMS

- A. Ground per applicable section on lightning protection system, NFPA 780, and as specified herein. The most stringent requirements shall govern.
- B. Bond lightning protection system grounds to electrical service system ground, all piping entering or leaving all buildings, and counterpoise system ground where provided.
- C. See Section 16671 Lightning Protection System.

3.7 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

- A. General:

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1. All equipment (including chillers, pumps, disconnects, starters, control panels, panels, etc) mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.
  2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by applicable table in NEC 250 based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.
- B. Complete installation shall exceed the minimum requirements of NEC 250 and, when applicable, NFPA 780.

3.8 ROOF MOUNTED EQUIPMENT

- A. Bond all roof mounted electrical equipment to lightning protection system (when provided) per NFPA 780.
- B. Where lightning protection system is not provided, ground/bond all roof mounted electrical equipment to building steel and to two or more 30' ground rods at no less than 30' spacing driven vertically to a minimum depth of 30' plus 1' below grade.
1. Bond the two or more ground rods together with a Class I or Class II as required per NFPA 780 lightning protection main copper conductor.
  2. Provide additional rod electrodes as required to achieve specified ground resistance.
  3. Complete installation shall exceed the minimum requirements of NFPA 780.

3.9 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

- A. One 30 ft. ground rod electrode shall be driven vertically to a minimum depth of 30' plus 1' below grade in each manhole, handhole or pullbox (in ground).
- B. The complete installation shall exceed the minimum requirements of the NEC.
- C. Provide additional ground rod electrodes as required to provide resistance called for herein.
- D. Where more than one ground rod electrode is required bond the two or more ground rod electrodes together with a copper ground conductor.
- E. Bond to counterpoise system (whenever counterpoise system is provided.)
- F. Bond grounding electrode to all exposed metal parts of manhole, handhole, and pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL accepted grounding clamp. Provide 3' or more slack ground cable on cover connection as required to facilitate removal of cover.

3.10 MISCELLANEOUS GROUNDING CONNECTIONS

- A. Provide bonding to meet regulatory requirements.
- B. Required connections to building steel shall be with UL accepted non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will affect the structural properties of the steel. Required connections to existing building structural steel purlins/I beams shall be with heavy duty bronze "C" clamp with two bolt vise-grip cable clamp.
- C. Grounding conductors shall: be so installed as to permit shortest and most direct path from equipment to ground; be installed in conduit; be bonded to conduit at both ends when conduit is



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metal; have connections accessible for inspection; and made with accepted solderless connectors brazed (or bolted) to the equipment or to be grounded; in NO case be a current carrying conductor; have a green jacket unless it is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrode conductor shall be exothermically welded to ground rods, water pipe, and building steel.

- D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.
- E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.
- F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.
- G. Install ground bushings on all metal conduits where the continuity of grounding is broken between the conduit and the electrical distribution system (i.e. metal conduit stub-up from wall outlet box to ceiling space. Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.
- H. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in accordance with applicable table in NEC 250 for parallel return with respective interior grounding conductor.
- I. Grounding provisions shall include double locknuts on all heavywall conduits.
- J. Bond all metal parts of pole light fixtures to ground rod at base.
- K. Bond together reinforcing steel and metal accessories in pool and fountain structures and bond to electrical system per NEC.

### 3.11 TESTING AND REPORTS

- A. Raceway Continuity: Metallic raceway system as a component of the facilities ground system shall be tested for electrical continuity. Resistance to ground throughout the system shall not exceed specified limits.
- B. Ground resistance measurements shall be made on each system utilized in the project. The ground resistance measurements shall include building structural steel, driven grounding system, water pipe grounding system and other accepted systems as may be applicable. Ground resistance measurements shall be made in normally dry weather, not less than twenty-four hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.
- C. Upon completion of testing, the testing conditions and results shall be certified by the Contractor and submitted to the Architect/Engineer as called for in Section 16090 Test and Performance Verification.

### 3.12 INTERFACE WITH OTHER PRODUCTS

- A. Interface with site grounding system.
- B. Interface with lightning protection system installed under Section 16671 Lightning Protection System.

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- C. Interface with communications system installed under 16700 series specification sections.

3.13 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION

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SECTION 16180  
EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
  - 1. Electrical connections to equipment specified under other sections.

1.2 RELATED SECTIONS

- A. Summary of Work
- B. Conduit.
- C. Building Wire and Cable.
- D. Boxes.
- E. X-ray Equipment
- F. Electric Doors

1.3 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices.
- B. NEMA WD 6 - Wiring Device Configurations.
- C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of the General Requirements of the Contract Documents and Section 16012.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.6 COORDINATION

- A. Submit under provisions of the General Requirements of the Contract Documents and Section 16010.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- E. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

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- C. Cord Construction: ANSI/NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Section 16061.
- B. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations (including inside of coolers/freezers).
- C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment and in cooler/freezers.
- D. Provide receptacle outlet where connection with attachment plug is required. Provide cord and cap where field-supplied attachment plug is required.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Install disconnect switches, controllers, control stations, and control devices as required.
- G. Modify equipment control wiring with terminal block jumpers as required.
- H. Provide interconnecting conduit and wiring between devices and equipment where required.
- I. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

3.3 EQUIPMENT CONNECTION SCHEDULE

- A. By local authority and as required for a complete and operating service.
- B. X-ray Machine(s):
  - 1. Electrical Connection: Flexible conduit; provide field-installed disconnect switch.
  - 2. Voltage: 120 volts, 1 phase, 60 Hz.
  - 3. Load rating: 0.6 kva
  - 4. 2 #10, 3/4"c. (plus ground).
  - 5. Use manual motor starter switch with pilot light for disconnect switch.
  - 6. Connect 1"c. from each conveyor to x-ray monitor in console.
- C. Electric Door(s):
  - 1. Electrical Connection: liquid tight flexible conduit with local field installed disconnect switch and field installed control switch.
  - 2. Voltage: 120 volts, 1 phase, 60 Hz.
  - 3. Load rating: 1/2 hp.
- D. CCTV Equipment:
  - 1. Electrical Connection: wiremold plug strips as required with surge suppression.

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2. Voltage: 120 volts, 1 phase, 60 Hz.
3. 2 #10, plus ground, 3/4" c.
4. Use manual motor starter switch with overloads and with pilot light for disconnect switch.
5. Connect unit provided control switch as recommended by manufacturer. (3/4" c.)

END OF SECTION

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SECTION 16190  
HANGERS AND SUPPORTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Conduit and equipment supports.
  - 2. Anchors and fasteners.
- B. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pullboxes and other equipment furnished under this Division.

1.3 REFERENCES

- A. NECA National Electrical Contractors Association
- B. ANSI/NFPA 70 National Electrical Code

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA National Electrical Installation Standards.
- C. Do not fasten supports to pipes, ducts, mechanical equipment or conduit.
- D. Do not use spring steel clips and clamps.
- E. Obtain permission from A/E before using powder-actuated anchors.
- F. Obtain permission from A/E before drilling or cutting structural members.
- G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- H. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- I. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1" off wall.

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- J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- K. All items shall be supported from the structural portion of the building, except standard ceiling-mounted lighting fixtures, and small devices may be supported from ceiling system where permitted by Ceiling Contractor, however, no sagging of the ceiling will be permitted. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.
- L. This Contractor shall lay out and install his work in advance of the laying of floors or walls, and shall furnish and install all sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, this Contractor shall furnish and install all inserts and clamps for the supporting of conduit. If this Contractor does not properly install all sleeves and inserts required, he will be required to do the necessary cutting and patching later at his own expense to the satisfaction of the Architect.
- M. All conduits shall be securely fastened in place per NEC. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits will not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.
- N. Where two or more conduits are run parallel or in a similar direction, they shall be grouped together and supported by means of Kindorf type trapeze hanger system (racking) consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or accepted clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
- O. Hanger assemblies shall be protected after fabrication by galvanizing. Hangers for PVC coated conduit shall be PVC coated galvanized conduit or stainless steel.
- P. On concrete or brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head screws shall be used. An electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Fasteners similar to "TAP-CON" self tapping power driven type are acceptable. Plastic anchors are not acceptable.
- Q. Conduit supporting devices such as spring type conduit clips manufactured by Caddy Corporation may not be used.
- R. Threaded rod hangers shall be galvanized continuous thread type, minimum 3/8" diameter.
- S. Concrete/insert anchors, threaded rods, or similar fasteners installed on side or bottom of prestressed beams are not acceptable.

END OF SECTION

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SECTION 16195  
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide and install all equipment, labor and material for a complete identification system, including but not limited to:
  - 1. Nameplates and labels.
  - 2. Wire and cable markers.
  - 3. Conduit markers.
- B. Identify all new and modified existing conduits, boxes, equipment, etc. as specified herein.

1.3 REFERENCES

- A. ANSI/NFPA 70 National Electrical Code.
- B. Americans with Disabilities Act

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2- PRODUCTS

2.1 NAMEPLATES

- A. Nameplates shall be laminated phenolic plastic, chamfered edges.
  - 1. 120/208 Volt System:
    - a) Black front and back, white core, lettering etched through outer covering, white engraved letters on black background.
  - 2. For 277/480 Volt System:
    - a) Orange with white letters.
  - 3. Emergency System:
    - a) Red with white letters.
- B. Letter Size:
  - 1. 1/8" letters for identifying individual equipment and loads.
  - 2. 1/4" letters for identifying grouped equipment and loads.
- C. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the Drawings, inscription and size of letters shall be as shown and shop drawing submitted for acceptance. Nameplates for panelboards, switchboards, motor control centers, disconnects and enclosed breakers shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 120/208V, 3-phase, 4-wire." In addition, provide phenolic label in panel to describe where the panel is fed from and location. For



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- D. The following items shall be equipped with nameplates:
1. All motors, motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches, transformers, panelboards, circuit breakers (i.e., all 2-pole, 3-pole circuit breakers), contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical, and electrical systems (Systems Sections 16700 through 16799), junction and pull boxes (larger than 4-11/16"), terminal cabinets, terminal boards, and equipment racks. Nameplates shall also describe the associated panel and circuit number, if applicable.

2.2 WIRE MARKERS

- A. Description: Cloth, tape, split sleeve or tubing type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
- C. Legend:
  1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings including neutral conductor.
  2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.3 CONDUIT/JUNCTION BOX COLOR CODE

- A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

<u>COLOR CODE FOR JUNCTION BOXES</u>	<u>KRYLON PAINT NUMBER</u>
System Emergency 277/480 volt	Cherry Red K02101
System Emergency 120/208 volt	Zinger Pink S01150
Fire Alarm	Popsicle Orange K02410
Normal Power 277/480 volt	Leather Brown K02501
Normal Power 120/208 volt	Glossy Black K01601
Security/CCTV	John Deere Green K01817
Grounding	Fluorescent Green K03106

- B. Conduit (not subject to public view) longer than 20' shall be painted with above color paint band 20 ft. on center. Paint band shall be 4" in length, applied around entire conduit. Where conduit is parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniform. Paint boxes and raceways prior to installation, or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.
- C. Junction boxes and conduits located in public areas (areas that can be seen by the public) shall be painted to match surface to which it is attached. Provide written request to A/E for interpretation of those public areas which may be in question.

2.4 CONDUIT/JUNCTION BOX MARKER

- A. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately describe its associated panel and circuit reference number(s) within (i.e. ELRW-2, 4, 6), or systems within (i.e. fire alarm, intercom, etc.).

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Identification shall be neatly written by means of black permanent marker. Paint one-half of cover plate with appropriate color above, and one-half with associated panel/circuit or system as described above. Junction box cover plates located in public areas shall be identified with small phenolic labels securely attached. Label colors to be determined by A/E. Large pull/junction boxes (8" x 8" or larger) shall be color identified by painting the corners of box cover plate with specified colors at 45 degree angles; phenolic labels as specified herein.

- B. Identify conduit not installed in public areas with corresponding panel/circuit numbers or corresponding system type as described above. Spacing: 20 ft. on center adjacent to color identification bands.

2.5 UNDERGROUND WARNING TAPE

- A. Description: Minimum 6" wide plastic tape, detectable type, with suitable warning legend describing buried lines. Systems conduits shall have orange colored tape. Power/lighting conduits shall have red colored tape.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

- A. Install nameplate parallel to equipment lines.
- B. Secure nameplate to equipment front using stainless steel pop rivets.
- C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- D. Nameplates installed inside on dead front cover shall be self-adhesive tape. Do not drill or install screws in dead front.
- E. Identify new and modified existing conduit, junction boxes, and outlet boxes using field painting.
- F. Identify new underground conduit using underground warning tape. Install a minimum of one tape per trench at 6" below finished grade. For trenches exceeding 24" in width, provide one tape per 24" of trench width spaced evenly over trench width.
- G. Install wire markers at all new connections and terminations, and at existing connections and terminations modified or altered.

END OF SECTION

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SECTION 16441  
ENCLOSED DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide all labor, materials, and equipment necessary to properly install switches as shown on the Drawings and as required by codes.
- B. Coordinate with Division 15 Contractor and Specifications as to who is to provide disconnect switches for mechanical equipment. Provide all disconnect switches not being provided by Division 15 Contractor.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver switches in factory wrapped packaging to the site. Handle switches carefully to prevent damage. Store in a clean, dry space protected from dirt, water, and physical damage. Do not install damaged switches.

1.4 QUALITY ASSURANCE

- A. The manufacturer of switches shall be the same as that of the panelboards.

1.5 SUBMITTALS

- A. Submit catalog cut sheet on each type of disconnect switch to be used on this project. Submit catalog cut sheet on enclosure locks to be used on this project.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

- A. Switches shall be 600V heavy duty types with visible, quick-make, quick-break blades.
- B. Units for 2-speed motors shall be 6-pole in a single enclosure. Use of two 3-pole units will not be acceptable.
- C. Provide ground bus, and where required a solid neutral bus.
- D. Switches shall be fusible or nonfusible as denoted on the Drawings or as required by the equipment served from the switch. Fusible switches shall have rejection type fuse holders.
- E. Terminal lugs shall be rated for 75 degrees Centigrade.
- F. Enclosures, unless otherwise noted, shall be NEMA 1 for indoor locations and NEMA 4X for outdoor locations as a minimum. All switches mounted outdoors including those noted to be NEMA 3R on drawings shall be heavy duty type 4X, watertight, corrosion resistant. In lieu of NEMA 4X, contractor may provide NEMA 3R disconnects if all surfaces of enclosure are coated with epoxy paint that will not scratch off.
- G. The enclosure shall be interlocked with the switch handle such that the enclosure door or cover cannot be opened with the switch in the "ON" position. The switch handle shall be capable of being padlocked in the "OFF" position but not in the "ON" position.
- H. Finish for NEMA I units shall be standard baked gray enamel finish over a rust inhibiting phosphate primer.
- I. Each disconnect switch shall be provided with a Homac #ELB-2 or similar enclosure lock. Homac #ELB-2 is available from Graybar Electric.

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- J. Disconnect switches installed between any variable speed drive type of unit (VFD, AFD, USD, etc.) and its respective motor(s), shall have auxiliary break before break (open) interlock control contact.
- K. Disconnect switches installed to disconnect HVAC equipment are to be fusible type with fuses as recommended by HVAC manufacturer.

2.2 RATING

- A. The size, number of poles, and fusing for each switch shall be as denoted on the Drawings. As a minimum, no less than one pole for each ungrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.
- B. Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch. Switches serving motor loads shall be horsepower rated of sufficient size to handle the load.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all switches in accordance with the manufacturer's written instructions, NECA National Electrical Installation Standards, the applicable requirements of the NEC, and recognized industry practice.
- B. All switches shall be firmly anchored to walls and supporting structures (where used) using appropriate installation. Switches shall be installed with the turning axis of their handles approximately 5'-0" above finished floor unless otherwise indicated. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.
- C. Switches shall be mounted in accessible locations chosen where the passageway to the switch is not likely to become obstructed. Where a switch serves as the disconnecting means for a load, the switch shall be located as close as practical to the load with the switch handle within sight of the load.
- D. Provide and install lugs on disconnect switch as required to accept conductors called for on Drawings.
- E. Disconnect switches shall not be mounted on equipment, unless specifically noted or required and meet all applicable codes, etc. If switches are noted or required to be mounted on equipment they shall have vibrator clips on fuses and be connected to conduit system with liquid tight flexible conduit.
- F. Provide and install enclosure lock on each disconnect switch. Enclosure lock bolt shall be tightened firmly but not tight enough to break bolt.
- G. Coordinate all requirements for controls between variable speed drive units and its respective motor with drive specification, manufacturer, provider and installer. Provide auxiliary contacts, relays, etc. as required.
- H. Install all labels and identification as required by the NEC and applicable sections of these specifications.

END OF SECTION

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SECTION 16484  
MOTOR CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section of the Specification covers factory-assembled, metal-enclosed motor control units for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.
- B. Motor control units shall include all protective devices and equipment as listed on Drawings or as included in these Specifications, with necessary interconnections, instrumentation, and control wiring.

1.3 FURNISHING OF EQUIPMENT

- A. Unless specifically noted otherwise, automatic motor starters for all equipment requiring them shall be furnished under the section or division where equipment is specified, and installed under this Section of the Specifications.
- B. Provide all labor, materials, and equipment necessary to properly install all motor starters or VFDs. Provide motor starters for all new motors to be wired, where starters are not elsewhere specified under work of that division which provides the motored equipment.
- C. Unless specifically noted otherwise manual motor starters shall be furnished and installed under this Section of the Specifications.
- D. Disconnect switches for 120V fractional hp exhaust fans to be provided by Division 15 Contractor at exhaust fan. Any other required disconnect switch to be provided and installed by Division 16 Contractor.
- E. Motor control center and associated starters shall be provided (under this section) or (by Division 15) of the Specifications.
- F. Provide and install 75 degree rated lugs on all non-unitary mechanical equipment such as pumps, air handling units and individual motor units/equipment. Coordinate with Division 15 Contractor prior to bid.
- G. Where a disconnect switch is mounted between an adjustable frequency drive and the motor, the disconnect must have a late make, early break auxiliary contact. This contact shall be wired into the AFD control circuit so that the control circuit is disconnected before the power circuit is broken

1.4 CONTROL ITEMS

- A. Unless specifically noted otherwise, all control, alarm and interlock wiring required for proper operation of equipment furnished by any other contractor and the required raceways shall be furnished and installed under the division where the equipment is specified.
- B. Where required by Electrical Drawings, Division 15 Specification, and/or Mechanical Drawings, this Contractor shall connect power feeder to mechanical equipment via control devices furnished by Division 15 Contractor (i.e. starters, line voltage, t'stats, line voltage switch, control relays, etc.).
- C. Provide and install power circuits to all control devices requiring them (i.e. 120V dampers, control panels, control devices, etc.) whether shown on Drawings or not. Coordinate

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requirements of all Divisions and/or Sections of these Specifications prior to bid.

1.5 SUBMITTALS

A. Shop Drawings and Product Data:

1. Shop Drawings, Individually mounted AC Manual Starter:

a) Shop Drawings shall clearly indicate:

1. Frame sizes and Interrupting Capacity of manual starter and/or disconnect unit.
2. Horsepower rating at rated voltage of manual starter and/or disconnect unit.
3. Electrical ratings.
4. Single line diagram for power and control connections with numbered terminals and all required accessories.
5. All required accessories.

2. Shop Drawings, Individually mounted AC Magnetic Starter:

a) Shop Drawings shall clearly indicate:

1. Frame sizes and interrupting capacity of starter and/or disconnect unit.
2. Horsepower rating at rated voltage of starter and/or disconnect unit.
3. Electrical ratings.
4. Single line diagram for power and control connections with numbered terminals and all required accessories.
5. All required accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Square D

B. Accepted Substitutions:

1. General Electric
2. Siemens/ITE

2.2 GENERAL

- A. Motor starters shall be manual, magnetic, or combination type as denoted on the Drawings.
- B. Pilot lights shall have long-life lamps rated 7500 hours minimum.
- C. Enclosures shall be NEMA 1 for indoor locations and NEMA 3R for outdoor or wet locations except where indicated as NEMA 4.
- D. Multi-speed or stop type controllers shall have thermal overload relays in each ungrounded conductor for each speed or step.
- E. Where multi-speed motors are scheduled on the Drawings, the motor controls shall be compatible with the type motor and have adjustable time deceleration for transition from high to low speeds.

2.3 INDIVIDUALLY MOUNTED AC MANUAL STARTERS

- A. Where manual motor starter switch is called for on Drawings, it shall be a combination across-

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the-line manual type starter with overloads and disconnect rated in accordance with NEMA standards, sizes and horsepower rating. Final rating of overloads shall be field set and recorded. Unit shall be mounted on NEMA 1 enclosures, unless otherwise noted.

- B. Manual motor starter switch shall include green "run" pilot light, and shall be surface or flush mounted as noted on Drawings.

2.4 INDIVIDUALLY MOUNTED AC MAGNETIC STARTERS

A. Combination Starter and Disconnect:

- 1. Where combination starter and disconnect switch is called for on Drawings, it shall be a combination across-the-line magnetic type starter with motor circuit protection (magnetic only breaker) disconnect, rated in accordance with NEMA standards, sizes and horsepower rating. Final magnetic setting of MCP shall be field set and recorded with unit shall be mounted on NEMA 1 enclosures, unless otherwise noted.

B. Individual Starter Without Disconnect:

- 1. Where individually mounted starter is called for on Drawings, it shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes, and horsepower ratings. Unit shall be mounted on NEMA 1 enclosure, unless otherwise noted.

C. Starters:

- 1. Motor starter, unless otherwise noted, shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes, and horsepower ratings. Starters shall be equipped with double break silver alloy contacts. All contacts shall be replaceable from front without removing starter from enclosure. Overload relays shall be provided in each phase, and shall be melted alloy or bimetallic type. Thermal units shall be of the one-piece construction and interchangeable.
- 2. Starters shall be equipped with minimum of two (normally open) auxiliary contacts in addition to the normally open auxiliary seal-in interlock and shall be suitable for the addition of at least two additional external electrical interlocks, one normally open and one normally closed. All starters shall have red "run" pilot light, "Hand-Off-Auto" selector switch, and nameplate. Control voltage shall be as required. Starters shall contain fused control transformers to provide correct control voltage.
- 3. Starter for all 3-phase motors shall include 3-phase power monitor as manufactured by Time Mark Corporation (Model #A258B for 480V, 3 phase system) (Model #258B for 208V/240V, 3 phase system) (Model #B258B for 120V system) providing solid state protection by opening starter for loss of any phase, low voltage of any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage of (340-480VAC) (160-240VAC) (85-125VAC).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine area to receive motor-control units to assure adequate clearance for motor control unit installation.
- B. Start work only after unsatisfactory conditions are corrected.
- C. Check that concrete pads are level and free of irregularities for motor control centers.

3.2 INSTALLATION

- A. Install motor control units in accordance with manufacturer's written instructions and NEC.
- B. All starters and their respective enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels

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on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Starters shall be installed with their turning axis of their handles approximately 5'-0" above finished floor. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.

- C. Starters shall be mounted where shown on the Drawings. Where the starter also provides the code-required disconnecting means for a load, the starter shall be located within sight of the load and as close as feasible.
- D. Provide fusing for all fusible switches.
- E. Provide properly sized heater elements for every starter overload relay. The element shall be sized using the nameplate full load running current of the actual equipment supplied to the job.
- F. Provide a heater element selection chart on the inside of each starter door.
- G. Provide spare pilot light lamps to the Owner. Provide two of each type and size load.
- H. Provide nameplate for each control units.
- I. Provide and install 75 degree rated lugs on all non-unitary mechanical equipment such as pumps, air handling units and individual motor units/equipment. Coordinate with Division 15 Contractor prior to bid.
- J. Coordinate conductor terminations on all equipment connections. Replace all 60 degree lugs/connections with 75 degree lug/connection.

3.3 ADJUSTMENT AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.
- C. Tighten bus connections and mechanical fasteners.

3.4 IDENTIFICATION

- A. Refer to Section 16195 Identification for Electrical Systems.
- B. Provide engraved plastic nameplates under the provisions of Section 16195 Identification for Electrical Systems.
- C. Provide labels and identification as required by the NEC.
- D. Nameplate shall show panel name, voltage and name of panel that feeds each motor starter device, and UL short circuit rating.
- E. Each motor starter device shall have engraved nameplate describing load/equipment being fed by device.
- F. All circuit identifications/nameplates shall be checked to verify accuracy of the description of the load and/or equipment being fed.

END OF SECTION



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SECTION 16671  
LIGHTNING PROTECTION SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
  - 1. Extension of existing Lightning Protection System.
  - 2. Air terminals and interconnecting conductors.
  - 3. Grounding and bonding for lightning protection.
- B. A Lightning Protection System shall be provided and installed on the structure(s) even though not shown on Drawings, by experienced installers in compliance with provisions of code for Lightning Protection Systems as adopted by the National Fire Protection Association and Underwriters Laboratories. All equipment to that result shall be included whether or not specifically called for herein with the additional requirement that the system shall meet all the requirements of LPI.
- C. Bond/ground all building mounted and/or grade mounted antennae and satellite systems/dishes.
- D. Extend existing Lightning protection system where modified for demolition and replacement of Out door Condensing Units.
- E. Materials shall comply in weight, size and composition with the requirements of Underwriters Laboratories and the National Fire Protection Code relating to this type of installation, and shall be UL labeled.
- F. All materials, where available by any one manufacturer, shall be cast.

1.3 REFERENCES

- A. ANSI/NFPA 780 Standard for the Installation of Lightning Protection Systems
- B. ANSI/UL 96 Lightning Protection Components
- C. UL 96A Installation Requirements for Lightning Protection Systems
- D. LPI Lightning Protection Institute
- E. OSHA Standard 29 CFR
- F. Section 16090 Tests and Performance Verification
- G. Section 16170 Grounding and Bonding

1.4 REGULATORY REQUIREMENTS

- A. System shall comply with the following:
  - 1. ANSI/NFPA 780 Class II
  - 2. UL 96A Master Label for:
    - a) Reconditioned installation.
    - b) UL 96A; Letter of Findings.

1.5 SUBMITTALS

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- A. Submit shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Drawings shall include full layout of cabling and points, and connections.
- B. Submit product data showing dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96.
- C. Submit manufacturer's installation instructions.
- D. Submittal shall include ground wells as called for in Section 16170 Grounding and Bonding.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit project record documents.
- B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and member of the Lightning Protection Institute.
- B. Installer: Authorized installer of manufacturer with minimum five years documented experience and member of the Lightning Protection Institute.

1.8 PRE-INSTALLATION CONFERENCE

- A. Convene a pre-installation conference one week prior to commencing work of this Section.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with roofing and exterior and interior finish installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thompson Lightning Protection, Inc. - Premium Line
- B. Independent Protection Company, Inc. - Premium Line
- C. Heary Bros. Lightning Protection - Premium Line
- D. Harger Lightning Protection, Inc. - Premium Line

2.2 MATERIALS

- A. Components: In accordance with ANSI/UL 96 and LPI.
- B. Air Terminals:
  - 1. Air Terminals shall be solid (aluminum or copper) as required to match roof conductors, and shall have proper base support for surface on which they are attached, and shall be securely anchored to this surface.
  - 2. Terminals shall be of such length as to comply with NFPA 780.
  - 3. Air Terminal for Chimney: Lead-coated copper.
- C. Conductors:
  - 1. Roof conductors shall consist of (aluminum or copper) complying with the weight and construction requirements of the code. Roof conductor material shall match and/or be compatible with roof flashing material.
  - 2. Down conductors shall be copper, and shall be provided where shown installed in PVC

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conduit and hidden within the structure.

3. If routing of down conductor raceway is in location where PVC is not allowed per code, install in metal conduit to meet code and bond both ends.
- D. Fastener:
1. Conductor fasteners shall be of the same material as the conductor, having ample strength to support conductor.
- E. Connectors and Splicers:
1. Above grade and accessible: They shall be bronze or aluminum as required to be compatible with conductor being connected.
  2. Below grade or concealed: exothermic connections
- F. Ground Rods:
1. Ground rods shall comply with all requirements of Section 16171 Grounding and Bonding and Section 16090 Tests and Performance Verification.
  2. Install in ground wells in accessible area (not in sidewalks, unless specifically accepted by engineer).
- G. Ground Plate: Copper.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify that field measurements are as shown on shop drawings.
- C. Beginning of installation means installer accepts existing conditions.

3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this Section from damage or disfiguration.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with UL 96A, ANSI/NFPA 780, and LPI.
- C. Install ground rods in accordance with Section 16171 Grounding and Bonding. Where conflict exists between the requirements of Section 16171 Grounding and Bonding and this Section, the most stringent shall govern.
- D. Installation shall be made in an inconspicuous manner with conductors coursed to conceal equipment as much as possible. Down conductors shall be concealed within structure, and shall be run in 1" conduit complying with NEC. See Paragraph 'F' below and NFPA 780 4.15.1.
- E. Where fasteners are to be mounted in masonry or structural work, they shall be furnished to the Masonry or Structural Contractor so they may be installed during construction of the project.
- F. Conductors concealed in steel reinforced concrete shall be installed, bonded, etc. per NFPA 780 4.15.3. Specific attention is brought to the requirements of NFPA 780 4.9.13 requiring down conductors to be connected to reinforced steel at its upper and lower extremities.
- G. Lightning protection system shall be bonded to metal bodies as required by NFPA 780 4.21.
  1. The Contractor shall provide proper connection of the lightning protection system to all grounded media in and around the protected structure (see NFPA 780 4.20 Potential Equalization).

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2. The Contractor shall provide proper grounding of all grounding media in, on and around structure to provide common ground potential per NFPA 780 4.14, including electric service, telephone and antenna system grounds, underground metallic piping systems, underground metal conduits.
  3. All fences, gates, handrails, metal flagpoles, metal bleacher seats, metal playground equipment shall be grounded and bonded to the grid.
  4. Bond/ground all building mounted and/or grade mounted antennae and satellite systems/dishes.
- H. Provide proper connections of lightning protection system to all grounded media in and around the protected structure per NFPA 780 4.20 Potential Equalization.
- I. Provide proper grounding of all grounding media in, on and around structure to provide common ground potential per NFPA 780 4.14 including electric service, telephone and antenna system grounds as well as underground metallic piping systems, underground metal conduits, etc.
- J. All exposed conductors located 6' or less above finished floor or finished grade is to be suitably protected/shielded as well as other exposed locations where conductor is subject to mechanical damage.
- K. Coordinate and receive acceptance of all penetrations of roofing system and mounting to roofing system with Architect and Roofing Contractor prior to submittal of shop drawings.
- L. Coordinate and receive acceptance of all connections to structural steel, rebar, etc. with Structural Engineer prior to submittal of shop drawings.
- M. Submittal of shop drawing by Contractor is evidence that the Contractor has received acceptance of penetrations, connections, etc. by all parties and that Contractor assumes responsibility for such penetrations, connections, etc.
- N. Ground Terminals:
1. Ground connections shall be made in accordance with requirements of all applicable codes and Section 16171 Grounding and Bonding (including but not limited to requirements for testing, ground rods, materials, wells, etc.).
  2. Ground rods shall be placed outside, a minimum of 2' from building foundations. Top of rod shall be at least 1' deep into earth (i.e. with minimum earth cover of 1'. Install in ground well. Install gravel/rock in base of all ground well, from well bottom to minimum of 6" below well bottom.
  3. Each and every ground rod location shall consist of:
    - a) Two or more 30' ground rods (5/8" copper) at no less than 60' spacing shall be driven vertically to a depth resulting in 1' earth cover.
    - b) Bond the two or more ground rods together with a cable size that meets the applicable requirements of NFPA 780 for Class I or II locations as applicable.
    - c) Provide additional rod electrodes as required to achieve specified ground resistance.
    - d) Complete installation shall exceed the minimum requirements of NFPA 780.
    - e) Provide grounding well enclosure at each ground rod location in accordance with Section 16171 Grounding and Bonding.
- O. Install in accordance with OSHA Standard 29 CFR Regulations 1910.23(c)(3), 1910.212, 1926.50

3.4 FIELD QUALITY CONTROL

- A. Test grounds per Section 16171 Grounding and Bonding and 16090 Tests and Performance

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Verification.

- B. Obtain the service of Underwriters Laboratories to provide inspection and certification of the lightning protection system under provisions of UL 96A.
- C. Obtain UL Letter of Findings and submit to Architect/Engineer.
- D. Submit test results on each ground location including final length of each ground rod and final distance between each installed ground rod at each ground rod location.

END OF SECTION

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SECTION 16723  
HARDWIRE FIRE ALARM/DETECTION SYSTEM (EXTENSION OF EXISTING)

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. The work described herein and on the drawings consists of all labor, materials, equipment, and services necessary and required to provide and test an extension of the existing automatic fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on the drawings but required for proper performance and operation shall be provided.
- B. The drawings and specifications herein comply to the best of the Engineer's knowledge with all applicable codes at the time of design. However, it is this Contractor's responsibility to coordinate/verify (prior to bid) the requirements of the authority having jurisdiction over this project and bring any discrepancies to the engineer's attention at least seven (7) days prior to bid. No changes in contract cost will be acceptable, after the bid, for work and/or equipment required to comply with the authority having jurisdiction.
- C. The contractor is advised that circuit routing for this system is not necessarily shown on the project drawings. The contractor shall provide and install all raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications. All wiring and/or cabling shall be in conduit. Contractor shall provide and install a properly sized, flush mounted outlet box for every device. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where raceway and/or conduit is not accessible after completion of the project, conduit shall be routed from device to device or fire rated access panels shall be installed to provide access to junction and pull boxes. Routing of raceway from device to device shall only be acceptable where the wiring scheme of the system, as recommended by the manufacturer, requires cable to pass from device to device. Contractor shall properly terminate each device according to the manufacturer's recommendations. Provide and install firestopping where penetrations are made through rated walls and floors.
- D. The Contractor shall provide and install the Fire Alarm system (including all equipment, wiring, etc.) in accordance with the Manufacturer's recommendations.
  - 1. Installation of devices shall be in accordance with the Manufacturer's requirements as well as the requirements of the Contract Documents. Recommendations by the Manufacturer for the proper installation of the Fire Alarm system and its equipment shall not preclude the requirement for the Contractor to comply with the requirements of the Contract Documents.
  - 2. Termination of Fire Alarm circuits shall be in accordance with the Manufacturer's recommendations, applicable requirements of the National Electric Code (NFPA 70), ADA, other applicable Codes and the Contract Documents.
  - 3. The Fire Alarm Installer shall be responsible for ensuring that prior to bidding the project the Electrical Contractor understands the raceway requirements for the project. Claims by the Contractor after award of the project in regard to additional raceway required either by the Fire Alarm System Manufacturer's recommendations for proper installation of the system and its associated equipment, or for compliance with the requirements of the Contract Documents, shall not be allowed.

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- A. The Owner shall be responsible for any retrofits, installation and design required by the local AHJ to comply with the requirements of the 2010 Florida Fire Prevention Code Section 11.10. This code requirement can only be determined after the construction of the building and may or may not be required by the local AHJ in the area of this project.
- E. The Contractor shall furnish and install a hardwire fire alarm system extension to match the existing system. The existing system is a Simplex 5208 Conventional fire alarm system. Control shall be microprocessor based and field-programmable. All electronics shall be solid state.
- F. Provide all materials, work, labor, etc. as required to modify (including any programming, battery capacity, etc.) the existing to comply with the operation, etc. noted in these contract documents.
- G. The system shall include but not be limited to:
  - 1. Main Fire Alarm Control Panel (FACP) including all required power supplies
  - 2. Duct Detectors
  - 3. Visual devices (indoor and outdoor weatherproof as indicated on the drawings)
  - 4. Remote fire alarm control panels (Network Nodes)
  - 5. Remote power supplies (Remote power supplies shall be in a UL Listed assembly and be provided by the same manufacturer as the Fire Alarm Control Panel (FACP)).
  - 6. Surge Suppression
  - 7. Re-Programming of existing system.
  - 8. Grounding
  - 9. Firestopping
  - 10. Wire and cable labeling.
  - 11. Electrical power required to comply with all functions and operations called for in this section of the specifications.
  - 12. Conduit, wire, wire fittings, terminal cabinets with plywood and terminal strips, and all accessories required to provide a complete operating system.
- H. The Contractor shall furnish and install all equipment (raceways, wire/cable, circuit breakers, modules, relays, etc.) necessary, and as required by applicable code to accomplish incidental functions of the fire alarm system including but not limited to the following:
  - 1. Elevator recall, control, and/or shutdown.
  - 2. Monitoring of Sprinkler System and/or Fire Protection System Flow and Tamper switches.
  - 3. Monitoring of Sprinkler System and/or Fire Protection System Valve Supervisory switches.
  - 4. Monitoring of Post Indicator Valve (PIV) switches.
  - 5. Gas/Fuel valve shutoff.
  - 6. Escalator shutdown.
  - 7. HVAC system control and/or shutdown.
  - 8. Ventilation system (supply fans, exhaust fans, fan terminal boxes, etc.) control and/or shutdown.
  - 9. Smoke Control system control and/or shutdown.
  - 10. Control of fire, smoke, and/or combination fire/smoke dampers.
  - 11. Monitoring of kitchen hood fire suppression systems

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12. Control of fire and/or smoke doors, dampers, shutters, etc.
  13. Computer room power panels and air conditioning control and/or shutdown.
  14. Control of door hold open devices.
  15. Control of time out room door lock devices.
  16. Connection to telephone tie lines, UL listed dialer, etc. required for monitoring of the fire alarm system.
- I. The system shall operate as a non-coded, continuous ringing system which will sound all audible devices and activate all visual devices until it is manually silenced. When system is silenced by silence switch in control panel, audible alarm is to silence but visual alarm devices are to continue to operate.
  - J. The system shall be wired same as existing system for all circuits.
  - K. The system is to be a complete hardwire system.
  - L. All portions of fire alarm system shall be installed in conduit. Conduit and boxes to be installed by electrical contractor.
  - M. The fire alarm system shall not share a raceway, junction box, enclosure, manhole or device with any other system.
  - N. Provide and install wiring, equipment, etc. for connection to devices furnished under other divisions of the work.
  - O. Provide and install wiring, equipment, etc. as required to deactivate power to computer power panels and air conditioning equipment by automatic or manual devices as shown on plans.
  - P. All required control and interlock wiring between the Fire Alarm system and building equipment shall be provided hereunder, and may not be indicated on the Fire Alarm system diagram and/or drawings. Controls are required to/for/from:
    1. Fire/smoke air and duct detectors
    2. Fire, smoke and/or combination fire/smoke dampers.
    3. Supply/Return fans, Exhaust fans, and/or Fan Terminal Boxes (FTB)
  - Q. Provide and install all relays (electric-electric, electric-pneumatic, and/or pneumatic-electric) as required for a complete and operational fire alarm system, complying with all applicable codes and all requirements, and coordinated with all divisions of these specifications.
- 1.3 STANDARDS, CODES, REFERENCES, AND REGULATORY REQUIREMENTS
- A. Reference Section 16014.
  - B. The equipment and installation shall comply with the current or applicable provisions of the following standards:
    1. ANSI S3.41 American National Standard Audible Emergency Evacuation Signal
    2. National Fire Protection Association Standards:
      - a) NFPA 70 National Electrical Code (including but not limited to Article 760, Fire Alarm Systems)
      - b) NFPA 72 National Fire Alarm Code
      - c) NFPA 101 Code For Safety to Life from Fire in Buildings and Structures
      - d) NFPA 90A Installation of Air Conditioning and Ventilating Systems
    3. Underwriters Laboratories. The system and all components shall be listed by Underwriters



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Laboratories for use in fire protective signaling system under the following standards as applicable:

- a) UL 864 (Category UOJZ) APOU Control Units for Fire Protective Signaling Systems. All Control Equipment shall be listed under UL category UOJZ.
  - b) UL 268 Smoke Detectors for Fire Protective Signaling Systems
  - c) UL 268A Smoke Detectors for Duct Applications
  - d) UL 217 Smoke Detectors for Single and Multiple Station Smoke Alarms
  - e) UL 521 Heat Detectors for Fire Protective Signaling Systems
  - f) UL 228 Door Closers-Holders With or Without Integral Smoke Detectors
  - g) UL 464 Audible Signal Appliances
  - h) UL 1638 Visual Signaling Appliances
  - i) UL 1481 Power Supplies for Fire Protective Signaling Systems
  - j) UL 1480 Speakers
  - k) UL 1424 Cables for Power-Limited Fire-Alarm Circuits
  - l) UL 1971 Signaling Devices for the Hearing Impaired
  - m) UL 1449 3<sup>rd</sup> Edition, Surge Protective Devices
  - n) UL 497, UL 497A, UL 497B.
4. All fire alarm equipment, including accessories to the system and including all wires and cable unless otherwise noted, shall be listed by the Underwriters' Laboratories product directory called Fire Protection Equipment and/or the Electrical Construction Materials List.
  5. Each item of the fire alarm system shall be listed and classified by UL and FM as suitable for purpose specified and indicated.
  6. The system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC 760.
  7. All equipment supplied as part of the Fire Alarm System shall be provided by a single manufacturer and shall comprise a complete UL Listed Fire Alarm System.
  8. IEEE: The fire alarm system includes solid state electronic components. Therefore, the equipment manufacturer shall provide certification that all such equipment is internally protected from, or can withstand, power line surge voltages and currents as specified in Table 1, Location Category A High Exposure of ANSI/IEEE Standard C62.41-1991.
- C. The equipment and installation shall comply with the current or applicable provisions of the following codes and laws:
1. Americans with Disabilities Act (ADA): The fire alarm system shall comply with ADA, Public Law 101-336, 1990. The system shall comply with ADA Accessibility Guidelines (ADAAG).
  2. Federal Register - Rules and Regulations - Non-discrimination on the basis of Disability by Public Accommodations and in Commercial Facilities.
  3. Local and State Building Codes.
    - a) Florida Administrative Code. All applicable chapters including but not limited to:
      1. Chapter 69A Rules, including but not limited to:
        - (a) Ch 69A-3 Fire Prevention - General Provisions.

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- (b) Ch 69A-27 Fire Prevention - Places of Assembly.
  - (c) Ch 69A-46 Fire Protection System Contractors and Systems.
  - (d) Ch 69A-48 Fire Safety Standards for the Fire Alarm Systems.
- 2. Florida Building Code Chapter 423 SREF (Schools)
  - 3. Florida Administrative Codes 33-8 (Jails)
- b) Florida Department of Insurance:
- 1. Insurance Code: The fire alarm system and installation thereof shall comply with the State of Florida Department of Insurance rules. The requirements of the Florida State Department of Insurance shall be as promulgated by the Division of State Fire Marshal.
  - 2. Fire Alarm Rules: The fire alarm system and installation thereof shall comply with the Fire Safety Rules promulgated by the Florida State Fire Marshal.
- c) Authority Having Jurisdiction:
- 1. General: The system shall comply with all applicable Codes, Ordinances and Standards as interpreted and enforced by the local authority having jurisdiction.
  - 2. Fire Department
  - 3. Building Official
  - 4. State of Florida: Division of State Fire Marshal.
- D. Surge Suppression
- 1. Equipment Certification: When available by any one manufacturer, all surge suppression equipment shall be listed by Underwriters' Laboratories, shall bear the UL seal and be marked in accordance with referenced standard. Such surge suppression equipment shall be UL listed and labeled for intended use.
  - 2. Comply with all standards and guides as listed under "References" above.

1.4 RELATED SECTIONS

- A. All applicable sections of Division 0, Division 1, and Division 16.
- B. Applicable sections of these specifications with regard to, but not limited to:
  - 1. Doors
  - 2. Exhaust hoods
  - 3. Standpipe and fire hose systems
  - 4. Sprinkler systems
  - 5. Extinguishing systems
  - 6. Ductwork accessories: smoke dampers
  - 7. Building control systems

1.5 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten (10) years experience and with service facilities within 50 miles of Project.
- B. Installer:
  - 1. Company specializing in installing the products specified in this section with minimum ten

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(10) years experience.

2. The Installer shall be currently licensed by the Electrical Contractors' Licensing Board as a Certified Alarm System Contractor I (EF).
3. The installing Contractor shall be a direct sales division of, or the authorized and designated distributor for, a fire alarm system manufacturer.
4. Installing Contractor shall maintain a local staff of specialists, including a Fire Alarm Planning Superintendent, for planning, installation, and service.
5. The installing Contractor shall maintain an office within fifty (50) miles of the project with capability to provide emergency service 7-days-a-week, 24 hour days. The installing Contractor shall have been actively engaged in the business of selling, installing and servicing fire alarm systems for at least ten (10) consecutive years going back from date of bid.

C. Surge Suppression

1. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electronics/communications systems equipment.
2. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor.
3. Verify proper clearances, space, etc. is available for surge suppressor.

D. Coordination/Project Conditions

1. Verify proper grounding is in place.
2. In installations where the electrical contractor does not provide a counterpoise system in conjunction with the underground raceway system, the fire alarm contractor shall provide a coupling conductor within the fire alarm underground raceway system to run along side fire alarm conductors. Coupling conductors shall be sized according to applicable codes and standards.

E. The work specified herein is an extension of the existing system and as such all equipment shall match existing. In the event that the existing equipment is no longer available other equipment will be considered for acceptance provided the following is submitted in writing by the system installer to the engineer (See Section 16010 on Substitutions):

1. Certified letter from the manufacturer specifically stating the following:
  - a) Part numbers and descriptions of each item that is no longer manufactured.
  - b) Manufacturer name (if not the same as the original manufacturer), part numbers and descriptions of items that are certified by the manufacturer to be compatible with the existing system.
  - c) A detailed listing of specific differences, including both advantages and disadvantages, between the original item and the proposed substitution.
2. Contractor qualifications (as listed above).
3. Complete lists, descriptions and drawings of materials to be used.
4. A complete drawing showing conduit, conduit sizes, backboxes, number of wires and wire sizes.
5. A complete riser diagram of Fire Alarm System.

1.6 SUBMITTALS

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- A. Submit in accordance with Sections 16010 and 16012.
- B. In addition to requirements of 16010 and 16012, the contractor shall submit:
  - 1. Narrative of operation of System as provided. (Submittal will not be reviewed by the A/E without this narrative.)
  - 2. Manufacturer's data on all products, including but not limited to:
    - a) Catalog cut sheets.
    - b) Roughing-in diagrams.
    - c) Installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
    - d) Operation and maintenance manuals.
    - e) Typical wiring diagrams and risers.
    - f) The contractor shall submit test reports, manufacturers' specifications and any other information necessary to determine compliance with material and equipment specifications described herein.
  - 3. Submit all load calculations and cable/wire sizing for each branch of the individual fire alarm field circuits. Wire sizing calculations to prove maximum three percent (3%) voltage drop at all AC voltages and maximum eight percent (8%) voltage drop at all DC voltages.
  - 4. Battery sizing calculations.
  - 5. Submit a detailed step by step testing procedure for a component by component system functional checkout and test.
  - 6. Point to point wiring diagrams and block diagrams of system to be installed. Point to point wiring diagrams may be submitted at time of operation and maintenance manuals in lieu of in submittal brochure. Block diagrams shall be required with submittals.
  - 7. Riser diagrams and floor plans showing conduit runs and number of wires. All devices shall be identified by the same applied identification symbol as shown on the drawings.
  - 8. Surge Suppression
    - a) Surge protective data for 120 volt power source, power circuit, outside signaling circuit, and exterior incoming circuits from other buildings (if any), and outgoing circuits to other buildings (if any).
    - b) Submit Product Data for each type of suppressor:
      - 1. Dimensions.
      - 2. Means of mounting.
      - 3. Compliance with U.L Standards referenced.
      - 4. Compliance with IEEE Standards referenced.
      - 5. Design type (Hybrid, MOV).
      - 6. Size of wire leads.
      - 7. Warrantee.
      - 8. Performance data showing compliance with performance as specified herein.
      - 9. Complete schematic data on each suppressor type indicating component values, part number, conductor sizes, etc.

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10. Manufacturer's certified test data on each suppressor type.
11. Test data from an independent test laboratory.
9. Name, qualifications, etc. of company providing and installing system.
10. Qualifications of installer. Submit proof installer meets specified requirements.
11. Proof of UL Listing. Indicate the UL listing, the UL classification, and NEC insulation type used for each type of wire to be used in installation of fire alarm and communications system.
12. Manufacturer's drawings showing all dimensions (height, width, and depth) for all cabinets used to house system components. Provide catalog pages, mounting details and specification sheets for all fire alarm system components and rough-in boxes.
13. Submit Florida Registered Firm certificate number.
14. Submit Florida Fire Alarm Contractor's license number.
15. Submit Fire Alarm Technician(s) Manufacturer's certification.
16. Where required by Authority Having Jurisdiction submit signed and sealed documents as required by Authority Having Jurisdiction. Where Authority Having Jurisdiction requires shop drawings to be signed and sealed by a Registered Engineer, Contractor is required to submit same and include in his bid all costs associated with having a Registered Engineer other than the design Engineer of Record perform signing and sealing.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit in accordance with Sections 16010 and 16098.
- B. In addition to the requirements of 16010 and 16098, the contractor shall submit:
  1. Updated and revised contract documents to record actual locations (as-installed) of all equipment, devices, initiating devices, signaling appliances, and end-of-line devices.
  2. Record actual type, size, and routing of cables installed.
  3. Record all cable identifications.
  4. Drawings required herein are in addition to those required under "OPERATION AND MAINTENANCE DATA".
  5. All drawings required herein to be on AutoCAD 2007 or higher.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit in accordance with Sections 16010 and 16098.
- B. In addition to the requirements of 16010 and 16098, the Contractor's O & M Manuals shall include:
  1. A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item.
  2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codings (point-to-point wiring diagrams). System performance measurements shall be documented as noted elsewhere in this specification.
  3. Riser diagrams showing as-installed conduit with pull boxes, outlet boxes, physical cable layouts, part numbers of cable types used, and number of circuits in each conduit.
  4. Repair parts list for each and every major equipment item furnished.

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5. Service manuals for each and every major equipment item furnished.
  6. Manufacturer's warranties and operating instructions for each and every equipment item furnished. Include a copy of the certificate of warranty, signed by both parties.
  7. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.
  8. Surge Suppression
    - a) O & M data to include:
      1. All accepted shop drawings, product data, and/or cutsheets.
      2. Installation, connection, and maintenance information on each type of surge suppression.
      3. Procedure and/or time table for recommended periodic inspection of devices to determine continued usefulness.
  9. Complete equipment rack layouts showing locations of all rack mounted equipment items.
  10. CAD floor plans, prepared at a scale of not less than 1/16" = 1'-0" showing detectors, audible/visual locations and orientation, rack locations, and all other related device locations.
  11. The Contractor/Installer shall videotape the entire training session(s), and submit the video tape with the Operational Manual.
- C. Drawings required herein are in addition to those required under "PROJECT RECORD DOCUMENTS".
1. All drawings required herein shall be on AutoCAD 2007 or higher.

1.9 WARRANTY

- A. The contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from date of acceptance by owner, repair or replace any equipment found to be defective.
  1. No charges shall be made by the installer for any labor, equipment, or transportation during this period to maintain functions.
  2. Respond to trouble call within twenty-four (24) hours after receipt of such a call.
- B. The contractor shall guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.
- C. Surge Suppression
  1. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.
  2. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced by the manufacturer and installer at no cost to the owner.
  3. Equipment that is damaged by surges during warrantee period shall be replaced at no expense to Owner.

1.10 MAINTENANCE SERVICE

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- A. Furnish service and maintenance of fire alarm system for one (1) year from date of Substantial Completion.
  - 1. No charge shall be made by the installer and/or contractor for any labor, equipment, or transportation during this period to maintain functions.
  - 2. Respond to trouble call within twenty-four (24) hours after receipt of such call.

1.11 EXTRA MATERIALS

- A. Provide six (6) keys of each type.
- B. Provide three (3) of each type of automatic smoke detector without base.
- C. Provide three (3) of each type of surge suppression device.

1.12 OWNER'S INSTRUCTION

- A. Provide instruction to the Owner's designated personnel upon completion of the system installation. Instruction shall include a functional training session on fire alarm control panel operation and instruction on peripheral device operation, including what are normal indications and alarm indications of each type of new/added device. Videotape all training sessions and deliver (4) copies of tapes to Owner (for use in future training).

1.13 SYSTEM OPERATION

- A. System operation shall meet the operation requirements of all codes and regulatory requirements.
- B. Upon activation of the Fire Alarm System by a manual station, smoke detector, or any other new or existing automatic device, (except AHU smoke duct detector) the following shall take place:
  - 1. Energize all alarm signaling devices.
  - 2. Sound all audible alarms and flash visual signals throughout the campus. (See Item 9 below).
  - 3. Alert local fire department or proprietary system.
  - 4. Cause alarm to be displayed on the annunciator section of the control panel.
  - 5. Cause alarm to be displayed on remote annunciator
  - 6. Close all doors or fire shutters, held open by automatic release devices throughout the facility, or by zone (coordinate with architect and door hardware supplier, provide all electrical required).
  - 7. Unlock all electrically locked time-out room doors (coordinate with the architect and door hardware supplier, provide all electrical required).
  - 8. Shut down all air handlers, exhaust fans supplying or exhausting air, and fan terminal boxes (FTB) in at least the zone where the alarm is initiated.
  - 9. Shut down of air handling unit by a local smoke duct detector shall not activate audible alarms or flash visual signals, but shall provide a supervisory indication at the fire alarm control panel/fire alarm annunciator.
  - 10. Shut all fire and/or smoke dampers in ducts associated with the air handling units and exhaust fans which are shut down, in at least the zone where the alarm is initiated.
  - 11. Transmit signals to the building elevator control panel to initiate return to the main floor or alternate floor.
  - 12. Transmit signals to the building automation system to tell system that the fire alarm system has taken control of respective mechanical system.

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13. Send a signal to all dimming and lighting relay/control systems. Fire alarm signal shall initiate dimming system controls to drive all dimmed circuits to immediate full-on output. Fire alarm signal shall initiate lighting relay/control system to turn on all emergency lighting circuits.
  14. Send a signal to all non-fire alarm sound reinforcement systems (i.e. Cafeteria, Gymnasium, Multi-Purpose Room, Theater, etc.). Fire alarm signals shall override all other sound systems. Alarm notification signals shall take precedence over all other signals. Operation of other sound systems shall resume after fire alarm system clears alarm.
- C. System operation shall meet the operation requirements of all codes and regulatory requirements.
- D. Upon activation of the Fire Alarm System by a manual station the following shall take place:
1. Energize all alarm signaling devices.
  2. Sound all audible alarms and flash visual signals throughout the building.
  3. Alert local fire department or proprietary system.
  4. Cause alarm to be displayed on the annunciator section of the control panel.
  5. Cause alarm to be displayed on remote annunciator
  6. Close all doors, held open by automatic release devices throughout the facility, or by zone (coordinate with architect and door hardware supplier, provide all electrical required).
  7. Unlock all electrically locked doors (coordinate with architect and door hardware supplier, provide all electrical required).
- E. Upon activation of the Fire Alarm System by any smoke detector, any sprinkler flow alarm switch or other automatic detection device, the following shall take place in addition to the above:
1. Shut down all air handlers and exhaust fans supplying or exhausting air in at least the zone where the alarm is initiated.
  2. Shut all smoke dampers in ducts associated with the air handling units and exhaust fans which are shut down, in at least the zone where the alarm is initiated. (Coordinate with mechanical contractor and provide all electrical as required).
  3. Transmit signals to building elevator control panel to initiate return to main floor or alternate floor.
  4. Transmit signals to building automation system to tell system that the fire alarm system has taken control of respective mechanical system.
  5. Send a signal to all dimming and lighting relay/control systems. Fire alarm signal shall initiate dimming system controls to drive all dimmed circuits to immediate full-on output. Fire alarm signal shall initiate lighting relay/control system to turn on all emergency lighting circuits.
  6. Send a signal to all non-fire alarm sound reinforcement systems. Fire alarm signals shall override all other sound systems. Alarm notification signals shall take precedence over all other signals. Operation of other sound systems shall resume after fire alarm system clears alarm.
- F. Elevator: Smoke detectors associated with elevator lobbies, hoistways and machine rooms shall be types accepted by the Florida State Fire Marshal under FAC Chapter 4A-47 Uniform Fire Safety Standards for Elevators. Elevator recall shall be initiated ONLY by elevator lobby, hoistways and machine room smoke detectors. In addition to those functions outlined in "A" above, elevator detector(s) shall initiate the following functions.



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1. The operation of any one Elevator Lobby or Hoistway Product of Combustion Detectors associated with a single bank of elevators shall signal the elevator controls to commence required procedures for that bank of elevators. Refer to Division 14 for required procedures, floor(s) of recall, and alternate floor(s) of recall.
  2. The operation of any elevator machine room Product of Combustion Detector that is part of this Fire Alarm System shall signal the elevator controls to commence required procedures for that bank of elevators. Refer to Division 14 for required procedures.
  3. The activation of the smoke detector(s) in a machine room or hoistway shall cause a suitable warning light to flash. The light is to be located adjacent to the "Phase One" recall switch or elevator hall button at the designated and alternate fire department access level.
  4. Fire alarm system shall monitor shunt trip voltage per NFPA 72.
- G. System supervisory faults, such as shorts, opens, and grounds in conductors, operating power failure, or faults within supervised devices, shall place the system in the trouble mode, which causes the following system operations:
1. Visual and audible trouble signal indicated by zone at the fire alarm control panel.
  2. Visual and audible trouble signal indicated at remote annunciator panel.
  3. Trouble signal transmitted to central station.
  4. Manual acknowledgement function at fire alarm control panel shall silence audible trouble signal; visual signal shall be displayed until initiating failure or circuit trouble is cleared.
- H. Alarm Reset: The system shall remain in the alarm mode until manually reset with a key accessible reset function. The system shall reset only if the initiating circuits are cleared.
- I. Lamp Test: manual lamp test function causes alarm indication at each lamp on the fire alarm control panel and the remote annunciator.
- J. When the fire alarm system is activated as a drill, all incidental functions shall be exercised including notification of the fire department.
- K. Where required by codes or Authority Having Jurisdiction:
1. When system is silenced by silence switch in control panel, audible alarm is to silence but visual alarm devices are to continue to operate.
- L. The fire sprinkler valve tamper switch, when closed, shall annunciate a supervision signal at the fire alarm control panel and annunciator panels, if any. This supervision signal shall not cause a general alarm.
- M. Operation of auxiliary contacts in control panel to shut all smoke dampers in ducts associated with air handling units and exhaust fans which are shut down. (These shall not be controlled from detector unit contacts.)

1.14 ZONING

- A. Alarm Zones.
1. Regardless of the number of zones shown on drawings, the minimum alarm zones required are:
    - a) One per building, per floor for pull stations.
    - b) One per building, per floor for automatic devices.
    - c) One for each duct smoke detector.
- B. Notification Zones.

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1. Regardless of the number of zones shown on drawings the minimum notification zones (horns and strobe lights) required are:
    - a) One (or more) circuit(s) for administration building
    - b) One (or more) circuit(s) for exterior horns
    - c) One (or more) circuit(s) for remainder of campus.
  2. Breakdown circuits as required for load and distances involved.
- C. Alarm Zones.
1. Regardless of the number of zones shown on drawings, the minimum alarm zones required are:
    - a) One per 3000 square feet per floor, for pull stations and heat detectors.
    - b) One per 3000 square feet per floor, for smoke detectors.
    - c) One for each duct smoke detector.
- D. Notification Zones.
1. Regardless of the number of zones shown on drawings the minimum notification zones (horns and strobe lights) required are:
    - a) One per floor. Breakdown circuits as required for load and distances involved.

PART 2- PRODUCTS

2.1 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

- A. All equipment shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on the contract drawings shall be the best suited for the intended use and shall be provided by a single manufacturer.
- B. Provide all equipment to match existing equipment required to perform all functions and/or features included in this section of the specifications even though not specifically noted or specified herein.
- C. Modify/rework existing system as required for extension to new devices and/or as required for proper operation of system with new devices, adding new zone modules, adding surge suppression, adding power supply and battery capacity to meet regulatory requirements with new devices, etc.

2.2 RACEWAYS

- A. General:
  1. All raceways (conduit, wireways, pullboxes, outlet boxes, etc.) shall comply with applicable requirements of sections within Division 16 of these specifications.
  2. All raceways (conduit, wireways, pull boxes, outlet boxes, etc.) shall comply with all requirements of the manufacturer of the fire alarm system.
- B. Conduit: Comply with Section 16111 except as noted below:
  1. Pull Cords: Install pull cords in all raceway runs that are installed without cable.
  2. Size: Minimum size shall be 3/4" conduit.
- C. Boxes:
  1. All outlet boxes, junction boxes, pull boxes, etc. shall comply with applicable section of these specifications.

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2. Boxes shall be sized as required by the fire alarm system manufacturer and NEC for cables and/or device installed.

2.3 TERMINATION CABINETS

- A. Terminal cabinets are to comply with applicable sections of these specifications.

2.4 "SYSTEMS" AND "LOCAL" GROUND BUS

- A. Bus to comply with applicable sections of these specifications.

2.5 PHOTOELECTRIC SMOKE DETECTOR

- A. The contractor shall furnish and install, where indicated on the plans, photoelectric smoke detectors. The combination detector head and twist-lock base shall be UL-listed compatible with a UL-listed fire alarm panel.
- B. The base shall be directly interchangeable with ionization detector.
- C. The smoke detector shall have a flashing, status-indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.
- D. The sensitivity of the detector shall be monitored without removal of the detector head. Metering test points shall be accessible on the exterior of the detector head. Field adjustment of the sensitivity shall be possible when conditions require a change.
- E. The vandal-resistant, security locking feature shall be used in those areas as indicated on the drawings. The locking feature shall be field removable when not required.
- F. It shall be possible to perform a functional test of the detector without the need of generating smoke. The test method must simulate effects of products of combustion in the chamber to ensure testing of all detector circuits.
- G. To facilitate installation, the detector shall be nonpolarized. By using a furnished wire jumper, it shall be possible to check circuit loop continuity prior to installing the detector head.
- H. Voltage and RF transient suppression techniques shall be employed to minimize false alarm potential. A gated alarm output shall be used for additional detector stability.

2.6 DUCT MOUNTED SMOKE DETECTOR

- A. The air duct detector for the fire and smoke detection system shall provide detection of combustion gases and smoke in air conditioning ducts in compliance with NFPA 90A. The detector shall be UL specifically for the use in air handling systems. The detector shall operate at air velocities ranging from 300 feet per minute to 4000 feet per minute without requiring compensation for operation at specific air velocities. Sampling tubes of proper length shall be provided and installed to match duct width at the installed location.
- B. Whether shown on drawings or not, a remote alarm indicator and test switch, shall be provided for each duct mounted smoke detector to annunciate smoke detector operation remotely. Mount unit on wall in an occupied space (corridor, etc). Mount unit in ceiling or wall near respective remote smoke detectors (in an occupied space).

2.7 RELAYS

- A. Relays required for control (i.e. Air Handler shutdown, Supply Fan shutdown, Exhaust Fan shutdown, Fan Terminal Box shutdown, Door Lock release, Fire Shutter release, Smoke Damper closure, Fire Damper closure, Smoke/Fire Damper closure, or any other interface required by these specifications or applicable codes) shall be UL Listed relays suitable for use in Fire Alarm systems.
- B. Per NFPA, relays used for control of other systems shall be located within three feet (3') of the

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device to be controlled.

- C. Relays shall be controlled from the fire alarm system.
- D. Each relay shall provide at least one set of Form "C" dry relay contacts.

2.8 SURGE SUPPRESSION

A. Initiation Devices:

- 1. Plug-in replacement modular design with associated female wiring connector.
- 2. UL 497B listed and labeled.
- 3. Multi-stage hybrid protection circuit.
- 4. Fail short/fail safe.
- 5. Surge Capacity: 10KA with 8 x 20  $\mu$ s waveform, 500A per line with 10 x 700  $\mu$ s waveform.
- 6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700  $\mu$ s waveform.
- 7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
- 8. Capacitance: 1500 pf.
- 9. Manufacturer:
  - a) EDCO #PC642C series with #PCBIB base.

B. Data Loops:

- 1. Plug-in replacement modular design with associated female wiring connector.
- 2. UL 497B listed and labeled.
- 3. Multi-stage hybrid protection circuit.
- 4. Fail short/fail safe.
- 5. Surge Capacity: 10KA with 8 x 20  $\mu$ s waveform, 500A per line with 10 x 700  $\mu$ s waveform.
- 6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700  $\mu$ s waveform.
- 7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
- 8. Capacitance: 50 pf.
- 9. Manufacturer:
  - a) EDCO #PC642C-LC series with #PCBIB base.

C. Horn, Strobe, Control Power (Low Voltage):

- 1. Plug-in replacement modular design with associated female wiring connector.
- 2. UL 497B listed and labeled.
- 3. Multi-stage hybrid protection circuit.
- 4. Fail short/fail safe.
- 5. Surge Capacity: 5KA with 8 x 20  $\mu$ s waveform.
- 6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700  $\mu$ s waveform.

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7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Series Resistance: 0.2 ohms total per pair.
9. Manufacturer:
  - a) EDCO #P164 series (1 pair); #P264 series (2 pair), each with #SD12-PC base.

D. Terminations

1. Provide terminals sized for circuits required on project.
2. Where surge suppression modules are for mounting on 'M' block assembly, provide M block assembly complete with grounding system that mates with surge suppression equipment.

2.9 CABLE

- A. Contractor shall provide and install cable as required by the manufacturer, as specified elsewhere in these specifications, and to provide a complete, fully operational, UL Listed Fire Alarm system.
- B. Fire alarm system cables installed in exterior and/or underground raceways shall comply with the applicable sections of NEC 760.

2.10 WATERFLOW DETECTOR

- A. Waterflow switch to be supplied and installed by the mechanical contractor and wired in to Fire Alarm System by systems contractor. Zone as shown on zone schedule.

2.11 SPRINKLER SUPERVISORY SWITCHES

- A. Supervisory Switch to be supplied and installed by mechanical contractor and wired in to Fire Alarm System by systems contractor. Zone as shown on zone schedule.

PART 3- EXECUTION

3.1 INSTALLATION

- A. The contractor is advised that circuit routing for this system is not necessarily shown on the project drawings. The contractor shall provide and install all raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications. All wiring and/or cabling shall be in conduit. Contractor shall provide and install a properly sized, flush mounted outlet box for every device. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where raceway and/or conduit is not accessible after completion of the project, conduit shall be routed from device to device or fire rated access panels shall be installed to provide access to junction and pull boxes. Routing of raceway from device to device shall only be acceptable where the wiring scheme of the system, as recommended by the manufacturer, requires cable to pass from device to device. Contractor shall properly terminate each device according to the manufacturer's recommendations. Provide and install firestopping where penetrations are made through rated walls and floors.
- B. Locate, install, and test fire alarm and detection systems in accordance with the equipment manufacturer's written instructions, and the latest editions of the National Electric Code, the National Electrical Contractor's Association publication "Standard of Installation" and all applicable codes and standards referenced in this specification.
- C. Provide all work required for a complete system including complete system testing and checkout. All components shall be properly mounted and wired. The installation of this system shall comply with the directions and recommendations of authorized factory representatives.
- D. Provide wiring, cabling, raceways, and electrical boxes in accordance with manufacturer's written

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instructions.

- E. Components shall be electrically "burned-in" by operating the component at full power for a period as recommended by the manufacturer.
- F. Installation shall be done in a neat workmanlike fashion by a firm regularly engaged in Fire Alarm Installation and Service.
- G. The installation and inspection of all fire detection and fire alarm devices and systems shall be performed by, or under the direct on-site supervision of, a licensed fire alarm technician or a fire alarm planning superintendent who shall certify the work upon completion of the activity. The certifying licensee shall be present for the final test prior to certification.
- H. As-built plans and wiring diagrams shall bear the signature and license number of the licensed fire alarm planning superintendent, the date of installation and the name, address, and certificate-of-registration number of the registered firm.
- I. All components shall be completely wired. System shall be fully operable when main power service has failed and the Emergency Standby Generator has assumed emergency system loads. This shall require that any devices which required 120 volt power shall receive supply from an emergency 120 volt source.
- J. Installation of detectors:
  - 1. All ceiling mounted detectors shall be installed in accordance with the requirements of NFPA 72.
  - 2. All concealed detectors shall be provided with a remote indicating lamp and test switch installed in an occupied space (corridor, etc.) on wall or on the ceiling grid indicating the type of detector and the zone to which it is connected. Label shall be red with white lettering.
  - 3. Duct detectors shall be installed in accordance with NFPA 90A. All brackets and hardware shall be provided as required to install detector housing in correct position. All detector housings shall be sealed as required to prevent air leakage between duct and housing. Sampling tubes of proper length shall be provided and installed to match duct width at the installed location.

### 3.2 RACEWAYS AND BOXES

- A. Provide dedicated raceway with applicable boxes for all fire alarm wiring in accordance with applicable sections of these specifications.
- B. All initiating, indicating and auxiliary control devices shall be mounted on UL listed outlet boxes.
- C. Provide supporting devices per Section 16190.
- D. Identify raceways and boxes per Section 16195.

### 3.3 WIRE/CABLE

- A. Conductor: 98% conductivity, solid copper or stranded copper . If stranded conductors are used, then a compression lug shall be installed at every end. Wrapping twisted strands at terminal block screw is not acceptable. As an acceptable equivalent, stranded conductors without crimp-on lugs may be terminated into terminal strips of box-lug connectors.
- B. Insulation: A type accepted by NEC for the application. Individual conductors shall be Type THHN/THWN. All cable shall be UL listed for fire-protective signaling application. Communication, Class 3 or Multi-Purpose cables shall not be substituted for FP cable types.
- C. Size: All conductors shall be sized as prescribed by the system manufacturer, with following minimums:

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1. Multiplex Signaling Line Circuit: AWG #14, shielded twisted pair cable.
  2. Initiating Circuits, Hard-Wired Devices: AWG #14, THHN/THWN conductors.
  3. Notification Appliance Circuits: AWG #14, THHN/THWN conductors.
  4. Initiating Circuits, Addressable Devices: AWG #14, shielded twisted pair cable.
  5. Provide larger conductors where required to maintain voltage drop or signal strength within acceptable limits.
  6. The above wire sizes shall be increased to size as required to comply with authority having jurisdiction or as required for voltage drop, load, etc.
- D. Color Coded:
1. Wiring shall be color coded as required to match existing system.
  2. Permanent wire materials shall be used to identify all splices and terminations for each circuit at all junction boxes, outlet boxes, and terminations.
- E. UL:
1. General: Fire-protective signaling cable shall be UL listed as non-power limited or power limited as needed to match the output of the fire alarm equipment.
  2. Non-Power Limited: Fire protective signaling circuits classified as non-power limited shall use cable listed under UL Electrical Construction Materials Directory. Category HNHT, "NON-POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". all such cable shall have fire resistance, listing and markings as described in NEC 760.176. Minimum cable marking shall be NPLF.
  3. Power Limited: Fire protective signaling circuits classified as power limited shall use cable listed under UL Category HNIR, "POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". All such circuits shall be durably marked where plainly visible at terminations to indicate that it is a power-limited fire protective signaling circuit. Refer to paragraph titled "Fire Resistance of Cables" for additional requirements.
  4. Fire Resistance of Cables: Power-limited fire-protective signaling circuit cables shall be UL listed as described in NEC 760.179. All such cable shall bear a cable marking that includes a Type designation as given in NEC Table 760.179(I). Provide Type FPL.
- F. Connections of Installation Wiring:
1. Connections to Equipment: In accordance with NFPA for monitoring integrity and with the equipment manufacturer's instructions.
  2. Connections of installation wiring to alarm initiating devices and alarm indicating appliances shall be monitored for integrity.
  3. Interconnecting means shall be arranged so that a single break or single ground fault will not cause an alarm signal.
  4. Apply a compression lug, similar to T&B Sta-Kon Terminal, to all stranded conductors at terminations or use box-lug terminal strips.
  5. There shall be no wire splices. All wiring shall be continuous, uncut between devices and terminal blocks.
- G. Rated Enclosures:
1. All vertical fire alarm wiring traversing more than one level shall be routed in rated enclosures. In addition, all horizontal wiring serving devices location on floors other than where wiring originates shall be routed in 2-inch concrete encasement, suitable rated

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building construction, or 2-hour wrap application enclosure accepted by local authority having jurisdiction.

3.4 END-OF-LINE DEVICE

- A. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.

3.5 AUXILIARY CONTROL RELAYS

- A. An auxiliary fire alarm relay used to control an emergency control device, e.g. motor controller for HVAC system fan or elevator controller shall be located within 3 ft. of the emergency control device.
- B. The installation wiring between the system panel and the auxiliary fire alarm relay shall be monitored for integrity.
- C. Auxiliary control relays shall be listed for use with fire alarm systems.

3.6 CABLE IDENTIFICATION

- A. Provide and install permanent cable markers on all cables/wire lines, telephone lines, etc. at terminal strips, terminal cabinets and at main equipment.

3.7 SURGE PROTECTION

A. General

1. Provide, install and connect new surge suppression equipment as specified herein, including protection of equipment power source, cable/wire entering or leaving building housing, main fire alarm system equipment, ground lugs, #6 copper ground wire in 3/4" c. to existing main building service ground.
2. Extreme care shall be taken by contractor to assure a properly surge protected system.
3. Surge protection equipment must be selected by contractor to match the equipment being protected including wire sizes, operating volts, amps, and circuit impedance.
4. Installation of surge protection equipment and its grounding must be per manufacturer's recommendations to assure short and proper ground paths.

B. Equipment Selection

1. Contractor to coordinate with suppliers and installers of all equipment being protected and provide surge suppression equipment which meets these specifications on respective equipment, wires, etc.

C. Equipment Installation

1. Install surge suppression equipment per manufacturers recommendation at each wire terminal as noted under Part 1.
2. Install in surge suppression equipment terminal cabinets, etc. as required to facilitate installation of surge protection equipment and terminal points. Increase size of terminal cabinets (from that shown on drawings) to size required to facilitate installation of surge suppression equipment and terminal blocks.
3. Locate surge suppression equipment in terminal cabinet nearest main equipment cabinet (FACP).
4. Coordinate with Section 16691 contractor to assure that surge suppression for 120VAC power circuit and surge suppression required by this section are all installed in same terminal cabinet and bonded together.

D. Ground Installation



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1. Ground Bus Connections.
  - a) Provide "local" ground bus in each terminal cabinet housing surge protection equipment (with lugs, etc. as required).
  - b) Bond "local" ground bus to terminal cabinet with minimum #6 copper wire.
  - c) Connect terminal cabinet "local" ground bus to "systems" ground bus installed per 16170 with minimum #6 copper insulated wire (unless otherwise noted) in conduit.
  - d) Note that "systems" ground bar is also to be used for power transformation ground (480V to 208V) where applicable.
2. Surge suppression equipment grounding.
  - a) Connect each surge suppressor to local ground bus in terminal cabinet with wire sized as recommended by manufacturer. Where "M" block type terminations/surge suppressors are used, bond ground rail to local ground bar with wire as recommended by manufacturer.
  - b) Coordinate with Section 16691 contractor to assure that 120VAC power source/supply surge suppressor is also grounded to same local ground bus as surge suppressors provided in this section for same system (i.e. fire alarm, intercom, television, etc.).
3. Conductors.
  - a) Conductors shall meet requirements of Section 16123. Minimum size to be #12 THWN.
  - b) Bends in excess of 90 degrees in any grounding conductor shall not be permitted. A radius of 6 inches or greater shall be maintained on all bends.
  - c) Do not bundle unprotected conductors with protected conductors.
  - d) Conductors shall be kept as short as possible.
  - e) Conductors shall be secured at 12" intervals with an accepted copper clamp.
  - f) Grounding conductors shall be properly connected to the building service ground by accepted clamps.
4. Grounding Connectors
  - a) Connectors, splicers, and other fittings used to interconnect grounding conductors, bond to equipment or grounding bars, shall be accepted by NEC or UL for the purpose.
  - b) All connectors and fittings shall be of the Nicopress crimp or compression set screw type.
  - c) Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.
5. Telephone Circuits
  - a) Systems utilizing telephone company pairs as a transmission medium shall be provided with a suppressor conforming to device in Part 2 of this specification.
  - b) Suppressors shall be installed at each point where interface is made to telephone company pairs.
  - c) In cases where a modem or other device is used to interface with the telephone circuit the following procedure shall apply:

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1. Where the modem or coupling device is furnished by the telephone company the suppressors shall be installed on the system side of the modem or coupling device.
2. Where the modem or coupling device is furnished by the system contractor, the suppressor shall be installed on the telephone line side of the modem or coupling device.

3.8 EXISTING CONDITIONS

- A. Existing fire alarm control panel is to be extended to new devices as shown on plan.
- B. All existing fire alarm wiring and conduit is to be removed complete.
- C. Contractor shall investigate existing conditions prior to bid.

3.9 CONDUIT/BOX IDENTIFICATION

- A. Contractor shall identify fire alarm conduit and boxes with red paint in exposed locations. Identify conduit in concealed locations with 4" mark of red paint every 4'-0" OC.

3.10 DEMONSTRATION

- A. When system is complete it shall be demonstrated to owner's representative who shall be given complete instructions, spare parts, manuals and maintenance information.

3.11 SYSTEM TESTING

- A. Prior to certification of the fire alarm system the contractor shall accomplish a complete test of the fire alarm system in accordance with NFPA 72, Chapter 7, Paragraph 7-2 Test Methods.
- B. Perform a complete, functional, component by component test of the entire fire alarm and detection system. Provide a detailed step by step testing procedure which is unique to this project, reflecting the type of system and the number and location of all components.
- C. Demonstrate the proper operation of each component as follows:
  1. Ionization, photoelectric, and duct smoke detectors: activate the detector with a "false smoke" product which has been specifically formulated for testing smoke detection systems.
  2. Heat detectors: activate the detector by utilizing the detector check button.
  3. Pull Stations: activate the station by operating the station in its normal mode.
  4. Audible and Visual Alarms: verify proper operation when the system is put into the alarm mode.
  5. Sprinkler Flow Switches: open the sprinkler system's inspection test valve. Verify that the flow switch sends an alarm signal within the allowed time corresponding to the switch's time delay setting.
  6. Fire Alarm Panels: functionally check-out and test the panel per the manufacturer's written instructions. Demonstrate the proper operation of each modular component. Demonstrate automatic power change to batteries and back to building power upon a drop in voltage below the voltage threshold as specified by the panel manufacturer.
- D. Demonstrate the supervisory function at each device loop circuit, and at all single component wiring runs such as for the sprinkler valve supervisory switches.

3.12 CERTIFICATION

- A. After completion of the installation of the system, the licensee shall complete a NFPA Inspection and Testing form. The Inspection and Testing form format shall be as indicated in NFPA 72, Chapter 7, Figure 7-5.2.2 Inspection and Testing Form. When an Inspection and Testing form

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has been completed, legible copies shall be distributed as directed by the Authority Having Jurisdiction.

- B. After an installation has been complete, affix a Fire Alarm Tag to the control panel. The Fire Alarm Tag is in addition to the Inspection and Testing form. Protect the Fire Alarm Tag from vandalism by applying pressure sensitive label; do not use a "tie-on" tag. It shall be as required in the Fire Safety Rules.

3.13 FINAL DRAWINGS

- A. As-built drawings shall be given to the Owner's representative, at time of instruction, in addition to those to be supplied as general requirements of the job.

3.14 AUTHORITY HAVING JURISDICTION

- A. The drawings and specifications herein comply to the best of the engineer's knowledge with all applicable codes at time of design. However, it is this Contractor's responsibility to coordinate/verify (prior to bid) the requirements of the authority having jurisdiction over this project and bring any discrepancies to the engineer's attention at least 7 days prior to bid. No changes in contract cost will be acceptable after the bid for work/equipment required to comply with the authority having jurisdiction.

END OF SECTION