HEATING, VENTILATION AND AIR CONDITIONING

DIVISION 15600

15610 GENERAL:

A. GENERAL:

This Contractor's attention is directed to the requirements of Instructions to Bidders, General Conditions and Supplementary General Conditions as bound in the specifications which apply in full to the heating, ventilation and air conditioning contract.

B. SCOPE:

Work in this section consists of furnishing of all labor, materials, equipment, and services reasonably incidental and implied for completion of the air conditioning, heating, exhaust and ventilation systems as described in these specifications and shown on the drawings, all in accordance with the contract documents. These drawings may be superseded by later revised or detailed drawings, specifications or sketches prepared by Designer and this Contractor

shall conform to all coordination requests. All items not specifically mentioned in the specifications or noted on the drawings but which obviously are required to make the working installation complete shall be included automatically.

C. CODES:

All work under this contract shall be done in accordance with the plans and specifications and all work shall comply with North Carolina Building Code, and with Underwriters' rules and regulations covering work of nature to be performed. Wherever plans or specifications are in excess of such laws, codes, regulations, etc., the plans and specification shall hold. All equipment so listed shall have U.L. label on it. All work must comply with all local codes and regulations. When more stringent requirements are imposed by governing regulations, they must be complied with.

If Contractor notes discrepancies between laws, codes, ordinances, rules and regulations and the specifications or drawings, each discrepancy shall be called to the attention of the Designer in writing before the bids are submitted.

D. PERMITS AND FEES:

This Contractor shall secure all permits required for the completion of this contract. He shall obtain and deliver to the Owner all certificates of inspection issued by the authorities having jurisdiction, with Contractor paying costs of same.

E. VISIT TO JOB SITE:

Before submitting a bid, this Contractor shall visit the job site for the purpose of thoroughly examining the site and conditions under which the work must be performed. The submission of a bona fide bid will be construed to mean that this Contractor understands and is satisfied with conditions under which the contract must be fulfilled. No extra

compensation will be allowed for situations arising from failure of the Contractor to thoroughly familiarize himself with site conditions, including charges and requirements for connection to utilities as shown for this project.

F. WORKMANSHIP:

Workmanship in the fabrication, preparation, and installation of materials and equipment shall conform to the best standards of practice of the trades involved. Work shall be performed by experienced and skilled mechanics under the supervision of a competent foreman. Substandard workmanship will be cause for rejection of work and replacement by Contractor. All costs associated with providing engineering assistance due to substandard work by the contractor shall be assumed by the contractor including time expended, telephone, and travel.

G. DRAWINGS AND SPECIFICATIONS:

The drawings show the location and arrangement of piping, ducts, and equipment, together with details of connections of certain principal items. The layout shown shall be followed as closely as circumstances will permit, but this Contractor shall lay out his work so as to avoid conflict with other Contractors, and trades, and to avoid any unnecessary cutting or damage to walls, floors, and supporting structural members. He shall, therefore, carefully and accurately locate all sleeves and install at the proper time all necessary hangers, inserts, etc., which will be required for the completion of his work and shall be solely responsible for the accurate and proper location of above items.

This Contractor shall refer to architectural, plumbing, and electrical drawings and shall cooperate fully with other Contractors and trades while installing ducts and other equipment because of close space limits. In case of conflict, notify Designer before proceeding with installation. Refer to architectural drawings for exact building dimensions and location of partition walls, doors, chases, etc. Mechanical drawings are not to be scaled for such dimensions.

Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Contractor to investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet the conditions.

The drawings and specifications complement each other and together are intended to give a complete description of the work. Any items of equipment or note of work to be done as shown on plans and not mentioned in the specifications, or mentioned in specifications and not shown on plans, shall be furnished the same as if mentioned or shown in both places. If conflicts exist, then the most stringent method shown or described shall apply. Any switches, controls, or equipment included in this contract work (drawings and/or specifications) that is not specifically shown on drawings shall be located for convenient use and access. Contractor to coordinate all equipment arrangement and lay-out in field prior to beginning any actual installation of his work.

If Contractor notes any discrepancy, omission, or conflict found in plans or specifications, he shall call to the immediate attention of the Designer, prior to receipt of bids. After contract is awarded, no claim for extra compensation will be approved for above reasons.

It is the intention that piping, air ducts and light fixtures are designed and laid out to clear each other. It shall be the responsibility of this Contractor to coordinate his work with that of other trades to avoid any such conflicts. Any conflicts that occur after work of one trade is installed and was not prior coordinated shall be relocated or rearranged at the total expense of this Contractor, as directed by Designer. Any conflicts that cannot be corrected in field by location or elevation changes shall be report to Designer in writing prior to any installation.

Provide all labor, materials, tools, equipment, and transportation and perform all operations necessary for and reasonably incidental to proper execution and completion of all "Mechanical" work, where specifically mentioned or not, all as indicated, specified herein, and/or implied thereby to carry out the intent thereof.

H. CUTTING AND PATCHING:

This Contractor before installing any of his work shall see that it does not interfere with clearances required for finished walls, partitions, equipment, etc., as shown on mechanical, electrical and architectural drawings and details. If any work is so installed and it later develops that the architectural design cannot be followed, this Contractor shall at his own expense, make changes in his work as directed by the Designer so that the architectural design may be followed.

Any cutting or patching required by the failure of this Contractor to install sleeves, inserts, hangers, etc., at the proper time, or failure to accurately locate above items, shall be done at his own expense. This Contractor shall advise General Contractor at proper time an exact location of all roof, wall and floor openings. All such penetrations shall have sleeves.

Any cutting of walls or structures required for the installation of work under this division shall be done by this Contractor. Holes for passage of pipe and ducts shall be properly and neatly sleeved and grouted. All sleeve openings to be appropriately sealed at completion of construction. Sleeves through exterior walls shall be effectively sealed against passage of water. All disturbed areas shall be refinished and left in a finished and matching condition and must meet approval of Designer.

This Contractor shall properly firestop all floor and wall penetrations utilizing rated assemblies to provide the required fire protection. Firestopping is to be installed in strict compliance with the U.L. through-penetration firestop system(s) applicable or as shown on the plans, or an approved equal. Submit shop drawings showing manufacturer's installation details/sections for approval. Persons installing firestopping shall have on site the approved firestopping submittals during installation, and at final inspection. Firestopping shall be installed per manufacturer's installation instructions and in strict compliance with U.L. rating.

All disturbed areas shall be refinished and left in a finished and matching condition and must meet approval of Designer.

I. INSPECTIONS AND TESTS:

No piping, duct work, or other installation shall be covered up or concealed until it has been tested and inspected as called for under appropriate sections of these specifications. This Contractor shall furnish all labor, fuel, equipment or special apparatus required, and bear all expense of such tests. The Designer shall be given advance notice of time tests are to be made, so a representative may be present to observe.

J. ALLOWANCE FOR ADDED WORK:

Before proceeding with any work for which compensation may be claimed or the Owner may claim credit, a detailed estimate shall first be submitted and approved in writing. No claim for addition to the contract sum will be valid unless so ordered and approved by the Owner and Designer, prior to start of work. Any conflicts corrected by relocation or elevation changes do not constitute extra work.

K. AS INSTALLED PRINTS:

This Contractor shall maintain a set of prints, showing exact locations of all relocated equipment, concealed equipment, service accesses, dampers, underground lines, and all other changes to plans. This set shall be kept current and turned over to the Designer upon completion of the job. Show dimensions to locate all underground piping from permanent reference points.

L. STANDARDS:

All work performed and equipment furnished by this Contractor shall be in accordance with applicable standards as published by ASHRAE, ANSI, NFPA, SMACNA, ASME, and UL.

M. INCIDENTAL CONSTRUCTION WORK:

All blocking for openings, ducts and pipes in concrete floors, masonry walls or partitions shall be provided by this Contractor. This Contractor shall do all cutting and fittings of his work and of other work that may be required to make the several parts come together properly and to fit his work to receive or be received by the work of other Contractors as shown upon, or reasonably implied by the drawings and specifications. He shall properly complete and finish up his work after other Contractors have finished as the Designer may direct.

All excavating required for the installation of this system shall be done by this Contractor and shall be unclassified; and backfill shall be accomplished as specified in appropriate section of specifications. Chases are prohibited in masonry walls which are not to be plastered or paneled. Set piping and ducts indicated to be concealed in unplastered or unpaneled masonry walls before walls are constructed in order that walls may be constructed around pipes or ducts. This Contractor shall furnish and install all sleeves in floor, beams, walls, etc., for such penetration as needed for installing his work and installation by General Contractor.

Unless otherwise noted, the General Contractor will provide openings and lintels as new construction progresses, but this Contractor shall fully designate his requirements prior to construction. Failure to furnish his requirements prior to

building construction shall make this Contractor responsible for removing, replacing and painting building construction as required for installation of his work.

N. CLEANING AND PAINTING:

This Contractor shall at all times keep the Owner's premises, the adjoining premises, driveways and streets clean of rubbish caused by this Contractor's operations and at the completion of the work shall remove all the rubbish from and about the premises, all his tools, equipment temporary work, surplus material and shall leave the work clean and ready for use.

This Contractor shall be required to perform touch-up painting on all factory finished equipment installed under this contract where necessary to repair abraded or scarred areas and make a clean and neat installation at the direction of the Designer. All metal exposed to weather shall be properly painted.

After the facility is ready for operation, clean all dirt from all machinery and equipment, fans, grilles, ducts, controls, etc.

Replace (disposable type) or clean and recoat (permanent type) all filters that have been used during construction at time of final acceptance.

O. SUPERVISION:

This Contractor shall have in charge of the work at all times during construction a thoroughly competent foreman with extensive experience in the work to be performed under this contract. Any one deemed not capable by the Designer shall

be replaced immediately upon request, and after satisfactory foreman has been assigned, he shall not be withdrawn without the written consent of the Designer.

P. GUARANTEE:

This Contractor shall guarantee all materials, equipment, workmanship and each and every piece of apparatus which he furnished and which he installs under this contract against defects and failures of any nature for a period of one year from date on which the system is accepted. Apparatus furnished by this Contractor shall be guaranteed to be satisfactory when operated under rated conditions in accordance with manufacturer's instructions and to be of function, size, and capacity specified on drawings or in the specifications. Upon notice from the Designer or Owner, he shall immediately check system, make necessary repairs or adjustments as required; due to faulty workmanship, materials, stoppages, operation or equipment, without cost to the Owner, and instruct Owner in proper operation, adjustment and care of systems. Contractor to send Designer a copy of each service call work order stating problem(s), findings, corrective actions taken and any items pending or unresolved; giving anticipated scheduled date for completing.

All refrigeration compressors to have five-year warranty by manufacturer.

The initial one-year warranty shall include periodic inspections and filter changing. A report of each inspection shall be sent to the Designer. A minimum of three inspections will be made during the first twelve months after acceptance. The Owner's maintenance personnel shall be instructed regarding routine operation and maintenance of the equipment during each inspection.

Upon expiration of the initial 12 month warranty/service period, this Contractor shall offer a continuing service program to the Owner, with a copy to the Designer. The program offered shall vary in content from a minimum service policy to

a maximum full coverage policy. The Owner shall have the option to elect to use either policy or none on an annual basis for a nominal fee or none.

Q. INTERFERENCES:

This Contractor shall cooperate with all Contractors on the building and shall confer with all Contractors installing mechanical work and equipment which may effect or come in contact with this work. He shall make necessary visits to site and examination of other trades to verify dimensions, installation conditions and conflicts, storage facilities, etc.; he shall examine approved shop drawings of all trades and arrange his work in proper relationship to other work and apparatus and with the architectural finish in an approved manner.

All equipment shall be installed to provide convenient access for service. Service access shall be as required by equipment manufacturer, whether or not specifically detailed on drawings. When equipment is not accessible from the ground; catwalks, service platforms, etc. shall be provided as required to allow access to equipment for maintenance.

It is the intent that piping, air ducts and light fixtures are laid out to clear each other; it shall be the responsibility of this Contractor to coordinate his work with that of other trades to avoid any such conflicts. Any conflicts that occur after work of one trade is installed and was not prior coordinated, shall be relocated or rearranged at total expense of this Contractor, as directed by Designer. The conflicts that cannot be corrected in field by location or elevation changes shall be reported to the Designer in writing prior to an installation.

R. IDENTIFICATION:

All equipment shall be identified and properly marked. All marking must meet Designer approval. All markers shall be of appropriate size. Minimum letter height 3/16". Each panel, starter, control, valve, and other pieces of equipment shall be identified as to their service, including each component and adjustment in control panels and equipment.

Numbered tags shall be attached to each valve and referenced in operating instructions where applicable. Seaton style 2070 tags or approved equal to be utilized. Where equipment requiring adjustment, servicing or checking is located above lay-in ceiling panels, each ceiling panel is to be identified with a coded marker signifying that it provides access to that particular equipment such as control devices, adjustment dampers, fire dampers, induction boxes, fans, heaters, etc.

Ductwork: All ductwork shall be identified as to the service of the duct and the direction of flow. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts need not be identified.

Piping: All piping shall be identified as to the service of the pipe and the normal direction of flow. The letters shall be one inch high on small pipe sizes and two inches high on large pipe sizes and the flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and black oil base paint with aerosol can. Concealed pipes need not be identified.

Equipment: All equipment, except in finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less that two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. In finished rooms, equipment shall be identified by engraved nameplates as specified.

S. MAINTENANCE AND OPERATION INSTRUCTIONS:

Operating and Maintenance Instructions on all equipment shall be provided:

Owner's manuals: Organize owner's operation, maintenance, and installation instructions into sets of manageable size. Bind in individual heavy-duty 3-ring vinyl-covered binders of appropriate size, with pocket folders for folded sheet information. Mark identification on front and spine of each binder. Submit four (4) complete copies to the Engineer for review prior to final inspection. Include the following information, with tabs to separate information for each piece of equipment:

Submittal data

Spare parts lists

Manufacturer's operating, installation, and maintenance instructions

Copies of warranties

Wiring diagrams

Preventive maintenance procedures and frequencies

Test and balance reports

As-Built Test & Balance Drawings

As-built control drawings

Report of factory start-ups, or contractor's check-out data

Valve tag lists

Names and addresses of manufacturer's or subcontractors and suppliers.

Provide rack in each equipment room for owner's manual storage. Provide a plastic envelope on the wall of each equipment room with inspection certificates, control diagrams, elementary wiring diagrams, piping schematics, valve lists, etc.

Prior to Application for Final Payment of the contract, this Contractor shall be responsible to train owner's personnel.

Owner training: Train owner's personnel in system and equipment operation and maintenance, including normal and emergency operation, start-up and shut-down, troubleshooting procedures, repair procedures, routine preventive maintenance procedures and frequencies, normal adjustments, safety precaution, warranty terms and procedures, and assistance available from manufacturer's authorized service representatives. Training is to include review of owner's manual information described above. Where required elsewhere in these specifications, training is to be conducted by manufacturer's authorized service representative or factory representative as part of equipment start-up specified. Upon completion of training, the organization conducting training shall submit on its letterhead to the Engineer a letter stating what training was conducted, date of training, names of owner's personnel trained, and name of person conducting training.

Upon acceptance of this letter, and final inspection and approval of this project, the one year warranty period on all equipment and systems installed by this Contractor shall start, from that date.

T. ELECTRICAL WORK:

This Contractor shall furnish, and install all electrical starters, disconnect switches, thermostats, controls, and safety devices required for the proper installation and operation of equipment installed under this contract. Switches, thermostats and controls shall be located for convenient access if not specifically located on drawings.

Electrical work under this contract shall start at MDP, wiring gutter, junction box or power panel provided by Electrical Sub-Contractor for service to equipment installed under this contract. See drawings for location and type of service connections to be provided under the electrical sub-contract. Electrical contractor to be a sub-contractor to the mechanical (prime) contractor.

This Contractor shall install conduit, power and control wire and outlet boxes for thermostats and interlocks, and wiring to equipment. This Contractor will pull control wiring and furnish all items of control equipment.

Work shall be installed in accordance with the most current edition of the National Electrical Code, and as specified in Section 16 of these specifications.

U. SHOP DRAWINGS:

Upon award of the contract, this Contractor shall submit to the Designer within ten (10) days, for approval, a list of all proposed sub-contractors and materials he proposes (within the three listed manufacturers as equivalent) to utilize for approval by Designer, Contractor to include a submittal schedule/status log listing all items of submittal and shop drawings on AIA Form G712 or similar form, and within 4 weeks of approval, supply eight (8) sets of shop drawings consisting of detailed drawings or manufacturer's cuts of all manufactured equipment he proposes to use on the job. The drawings or cuts shall show details of construction and arrangement and all pertinent data pertaining to equipment proposed to be furnished. The approval of the Designer shall be obtained before equipment is ordered for delivery.

Approval of the Designer shall be for general fitness and design only and final approval of substituted equipment is contingent upon its satisfactory performance. It will be the duty of this Contractor to verify quantities, dimensions, capacity, and details, and determine suitability of equipment for installation in space provided. Approval of shop

drawings by the Designer does not relieve this Contractor of the responsibility for coordination, dimensions, quantities, capacity, features, or details. If submittal shows variations from the contract requirements, the Contractor shall note on submittal and shall describe all differences (i.e., increased amperage, horsepower, physical size, capacity, flow, etc.) in writing (on letter of transmittal) separate from notations on submittal shop drawings.

This Contractor shall check and approve shop drawings making such notations and corrections as may be appropriate or necessary to comply with specifications before submission to the Designer. Submittals with variations and/or substitutions as equivalent by the listed manufacturers as specified or by those approved as equivalent 10 days prior to bid (see Materials Section) shall also contain a statement that this Contractor has coordinated same with other Contractors and Designers affected and list any changes required, refer to Materials Section.

Shop drawings and/or submittal data shall be submitted on items listed as follows:

Insulation Materials & Insulation Methods

Exhaust Fans

Automatic Controls

Flexible Duct & Fittings

Rectangular Ductwork and Fittings

Spiral Ductwork and Fittings

Grilles, Diffusers & Air Handling Accessories

AABC Balance & Testing Forms

Louvers, Dampers, Mixing Box Dampers

Fire Dampers / Fire-stopping

Roof-Mounted / Ground-Mounted Packaged Air Handling Units

Self-Contained Heat Pump Unit

Gas Pressure Regulators, Shut-off Valves, and Flex. Connectors

Roof Curbs, Penetrations, Supports

Electric Heaters

Electrical Distribution Equipment (Disconnects, Conduit, Starters, Breakers, Wiring, etc.)

Starters, Magnetic/Manual

Transformers

Wiring Devices

Electrical Distribution Equipment

Conduit & Wire

Firestopping for all Penetrations Applicable

V. TEMPORARY UTILITIES:

All necessary utilities such as water and electricity shall be furnished by Owner during construction, from his existing facilities.

W. EXISTING FACILITIES:

In existing facilities, disruption of operations must be kept to a minimum and coordinated with Owner. Work in existing buildings must be cleaned up daily immediately after finishing that portion of work and equipment left in order for

Owner to continue operations. When it is necessary to interrupt utility services in the fulfillment of this contract, such interruptions shall be kept to a minimum and coordinated with Owner. Once work has begun, it shall be pursued diligently until completed.

Every precaution shall be taken to prevent damage to existing underground lines and structures and public utilities. Damage to existing water and sewer lines, culverts, service connections, underground cables, and similar surface and sub-surface structures shall be at the risk of this Contractor, whether or not locations thereof are show on plans, and the repairing of such damage shall be by and at the expense of this Contractor, which shall be completed without delay.

The locations of any existing underground utilities that are shown are in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work, and agrees to be fully responsible for any and all damages which might be occasioned by the Contractor's failure to exactly locate and preserve any and all underground utilities.

X. ADAPTATION OF WORK TO EXISTING CONDITIONS:

It is reasonably implied that this Contractor is to furnish all labor and materials to provide Owner with a new and satisfactory system in these facilities. Contractor is to include necessary work for adaptation of equipment to conditions that may be found to produce conflicts during construction. When any such conditions are encountered, Contractor is to consult with Designer and then modify installation as directed without additional costs, and to include any incidental materials required.

Y. STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT:

The Mechanical Contractor shall be responsible for furnishing suitable shelter and protection of all materials and equipment stored on the job.

Equipment shall be protected from damage from any source both during storage and after installation until completion of the job. No damaged equipment will be accepted.

Z. CLEAN UP:

The Mechanical Contractor shall be responsible for keeping work areas clean and free of trash and debris resulting from his operations.

When work is conducted in occupied areas, clean up shall be accomplished daily and work areas left clean at end of day's work.

When all equipment and systems have been set and ready for use, they shall be thoroughly cleaned, removing all labels, plaster, rust and stains, checked for leaks, and left in perfect working order.

AA. DELIVERY AND HANDLING OF EQUIPMENT FURNISHED BY OTHERS:

All mechanical equipment furnished by Owner and others which is to be installed and connected by the Mechanical Contractor as hereinafter specified will be delivered and turned over to this Contractor. Storing and protection of such

equipment shall be done by this Contractor and the furnishing of all applicable accessories and miscellaneous fittings to make complete shall be provided by this Contractor.

BB. RESTORATION OF PROPERTY:

This Contractor shall carefully restore all property defaced by operations or acts of any of his agents or employees. Such restoration shall include seeding, sodding, and transplanting of lawns, hedges, ornamental planting, and the repair or replacement of driveways, walks, fences, steps, or other facilities in such a manner as to meet with the approval of the Designer and to be at least equal in quality to the original undisturbed work.

CC. RENOVATIONS/ALTERATIONS:

Survey: Before any work is started in existing building, Mechanical Contractor shall make a thorough survey with Designer and a representative of the Owner of building in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by all three to Designer. This report shall list by rooms and spaces:

1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout and affected areas of building.

2. Existence and condition and operation of items such as thermostats, EMS devices and accessories, HVAC equipment, etc., required by drawings to be either reused or relocated, or both.

3. Shall note any discrepancies between drawings and existing conditions at site.

4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and Designer.

Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of Designer and Owner's representative, to be in such condition that their use is impossible or impractical, shall be removed and a proposal submitted by Contractor to replace with new items in accordance with specifications which will be furnished by Designer.

Re-Survey: Fifteen days before expected partial or final inspection date, Contractor, Designer, Owner's representative, together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, mechanical devices and accessories, HVA/C equipment, etc., as compared with conditions of same as noted in first condition survey report. Telephone system shall be checked out and any damage caused by construction repaired to the satisfaction of this designer and owner.

1. Re-survey report shall also list any damage caused by this Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of this Contractor to restore damage caused by Contractor's workmen in executing work of this Contract.

DD. PROJECT CLOSEOUT

When this Contractor considers that his work is complete in all respects, per plans and specifications, he shall conduct an inspection of project with office and field supervision personnel and prepare a punchlist of outstanding/incomplete/deficient items of work. This inspection shall include review of all specified documentation, certificates, warranties, and close-out information.

When this Contractor considers the above punchlist to be completed or corrected he shall submit to the Designer, in writing, a request for Final Inspection. The request for Final Inspection shall have as attachments the following items:

-- Punchlist prepared by the Contractor, indicating by check-off all completed items (each item individually checked on the list, not a cover letter stating that all items on attached list are complete);

-- One copy of the Contractor's Maintenance and Operation manuals for review by the Designer;

-- As-built marked prints;

-- Copy of the Certificate of Occupancy issued by the local authority having jurisdiction;

-- Contractor's certificate that he has completed all work, per plans and specifications, that he has installed all items in accordance with manufacturer's installation instructions and all applicable codes, and that all systems/equipment furnished have been tested and are in full working order; (see enclosed Certificate Form);

-- Contractor's certificate that the as-built marked prints he provided are complete and accurate in all respects, and that any deviations from original design plans and/or specifications are clearly and accurately shown thereon, including all change orders;

-- Control subcontractor's certificate that all control components have been calibrated and tested and are in proper working order, and that the system is operating in accordance with the specified control sequence in all modes of operation;

-- Report of factory start-up on chiller, boiler, etc.;

-- Testing and balancing reports as specified.

-- Letters documenting Owner training in operation and maintenance of systems and equipment.

This Contractor is advised to allow adequate time in the project schedule to complete all work, including all specified testing, check-out, inspections, certifications, etc., prior to the contract completion date listed in the Notice to Proceed or other such notification, and before it is necessary for the Owner to occupy the facility.

Once the Final Inspection has been conducted, the Designer will issue to this Contractor a punch list of outstanding/deficient items. The Contractor will pursue corrective action to complete the Final Inspection punch list in an expeditious manner. Once all items on the Final Inspection punch list are complete, the Contractor is to submit to the Designer a copy of the Final Inspection punch list with all items checked off, attaching any outstanding documentation required. Additional visits by the Designer which may be required because above procedure has not been followed or accomplished; or, which are necessary to check off Final Inspection punch list items will be at the expense of the Contractor.

Refer to the General Conditions for the completion requirements. As a minimum, the following items must be fully complete, and proper documentation submitted to the Designer, before the Owner can be allowed to occupy any portion of the facility:

-- All life safety systems must be fully operational and certified, including fire alarm, emergency power, egress lighting, intercommunications, sprinkler, etc.

-- The HVAC system must be fully operational in automatic modes of operation and all control components calibrated and certified by the control system installer.

-- Approval of the local authority having jurisdiction through issuance of a Certificate of Occupancy.

-- Owner trained in operation and maintenance of systems and equipment.

CONTRACTOR'S CERTIFICATE OF COMPLETION

PROJECT: _____

CONTRACTOR:_____

I hereby certify the following:

a. That the work on the above-referenced project has been completed in accordance with the plans and specifications, and that all equipment and materials provided have been installed in accordance with manufacturer's installation instructions and all applicable codes;

b. That all items on specified contractor's inspection punch list (copy attached) are completed; and all items on designer's punchlist(s) are completed;

c. That all tests and inspections and sub-contractor's certificates and reports specified in the contract documents have been properly conducted and documented as specified, and that all equipment and systems are now completed and in proper working order;

d. That the as-built marked prints submitted to the Designer are complete and accurate in all respects, showing all deviations from original design plans and all other items specified;

e. That the following Owner's personnel were trained in operation and maintenance of equipment and systems installed under this contract (list names of Owner's personnel and date(s) training was conducted), as specified:

_____

_____

_____

_____

(Contractor)

_____

(Title)

_____

(Date)

15620 MATERIALS:

Materials and workmanship on all work installed under this contract shall be new and of the best quality and shall conform to the best practice for such work and be installed in accordance with manufacturer's recommendations and instructions, including all hardware and accessories recommended or appropriate. Any work or materials not specifically mentioned in these plans and specifications, but required to make this job a complete and workable system shall be furnished and installed by this Contractor. All materials, fixtures, apparatus and materials and methods of installation shall meet with approval of the Designer.

Certain items of manufactured materials and equipment are cited by manufacturer's or product name and model number. This is to establish a standard of design and quality, and is not intended to be restrictive as to the use of materials and equipment of similar design and equivalent quality by other manufacturers, which may be used subject to the approval of the Designer.

A. Proposed Equivalent Products: Items proposed as equivalent to those cited will be considered by the Designer **up to 10 days prior to receipt of bid,** and shall be subject to the approval of the Designer.

After that date, no equivalent material or substitution will be considered or approved, and all items shall be as specified.

Approvals to consider a proposed brand as being equivalent are for acceptable quality range and are not intended or to be construed as a detailed review of products, features, accessories, mounting hardware, compatibility with other equipment being furnished and space available. Preceding are the Contractors responsibility to insure a complete and coordinated installation of this product and must be submitted for approval and review as specified for submittal data. The approval to bid a proposed equivalent brand as a acceptable equipment design product does not relieve the contractor of this responsibility.

Equivalent Products proposed for approval for equipment specified must be equal in every respect and this Contractor shall base his proposal on the quality of materials and equipment covered in these specifications and shown on the drawings, complete with all accessories, hardware, features and functions to provide the same satisfactory performance on this project as the specified item or system. If required by the Designer, this Contractor shall submit for inspection samples of both the specified and the proposed substitute items for comparison by the Designer and test data from a recognized independent testing laboratory for both pieces of equipment.

Where equivalent products proposed and approved for bidding alter the design or space requirements indicated on the plans, this Contractor shall include all items of cost for the revised design and construction, including the cost of any changes or modifications in structural or architectural details, and/or electric service, and the cost of all allied trades involved resulting from use of equivalent product or equipment. This Contractor is to coordinate and bear all cost where such differences affect other Contractor's work.

B. Material Deliveries:

This Contractor shall provide to the Designer as soon as possible, and not later than seven (7) weeks after job is awarded, copies of factory acknowledgements of orders of all major items of material, i.e. air handlers, compressors, controls, special systems, etc. These acknowledgements should show date of factory entry and delivery dates promised by the supplier and be updated as job progresses or changes occur. Subsequent monthly applications for payment will not be processed for payment until above information is received each month.

C. TESTING AGENCY APPROVAL OR LISTING:

1) All fabricated assemblies of electrically operated equipment furnished under this contract shall have approval and listing of recognized third party agencies accredited by the NCBCC to label electrical and mechanical equipment as of August 1, 1991, or other agency satisfactory to authority having jurisdiction; in every case where such approval and listing has been established for said assemblies or equipment.

2) All manufactured items of electrically operated equipment shall have approval and listing of recognized third party agencies accredited by the NCBCC to label electrical and mechanical equipment as of August 1, 1991, or other agency satisfactory to authority having jurisdiction; in every case where such approval and listing has been established for said items of equipment.

15621 SEISMIC RESTRAINTS:

A. The Mechanical Contractor shall be responsible for providing restraints to resist the earthquake effects on the mechanical system. The requirements for these restraints are found in Chapter 16, of the North Carolina

Building Code.

B. Figures in the above code states that this project located in Henderson County, North Carolina --- with effective earthquake spectral response acceleration at short periods (Ss), earthquake spectral response acceleration at 1-second period (S1).

C. Chapter 16 states that parts or portions of the buildings or structure, non-structural components, and their anchorage to the main structural system shall be designed for seismic forces in accordance with the prescribed methods and formulas:

D. Chapter 16 gives the Seismic Building Category, as well as, the facility Seismic Design Category. *The Professional Engineer who is utilized by the Mechanical Contractor for the Seismic Design (See Below), shall select (and include in design submittals) the appropriate Seismic Building Category and Seismic Design Category based on calculation and usage, for each building and / or for each separate building area / usage (where required). Seismic Design Engineer shall consult with Architect and / or Engineer where function or usage of areas are in question. Refer to Architectural plans for area classifications.*

E. The Mechanical Contractor shall refer to the latest edition of the "Seismic Restraint Manual Guidelines for Mechanical Systems" published by SMACNA for guidelines to determine the correct restraints for sheet metal ducts, piping, and conduit, etc.

F. The anchorage of the equipment and machinery for this project shall an integral part of the design and specification of such equipment and machinery. Manufacturers of all equipment including air handling units, pumps, boilers, tanks, compressors, etc. shall provide anchorage details, isolators, seismic mounts and restraints, etc. necessary to comply with Chapter 16 to the Mechanical Contractor for installation. It shall be the Mechanical

Contractor's responsibility to provide and install the equipment, machinery, systems, and assemblies, etc. for this project which satisfy these requirements.

G. Notes / Tables in Chapter 16 of the North Carolina Building Code lists where seismic restraints are not required. Where seismic restraints are required, the Mechanical Contractor shall provide restraints per details and instructions included in SMACNA's Seismic Restraint Manual.

H. Mechanical Contractor shall include shop drawings of the specific methods of seismic restraint to be used for this project before installation of piping, ductwork, and equipment.

I. The Mechanical Contractor shall retain the services of a Professional Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The engineer's computations, bearing his professional seal, shall accompany shop drawings which show Code compliance. Computations and shop drawings shall be submitted for review prior to the purchasing of materials, equipment, systems, and assemblies.

J. Internal seismic restraint elements of manufactured equipment shall be certified by a professional engineer retained by the manufacturer. Such certificate applies only to internal elements of the equipment. All equipment anchorage requirements shall be coordinated with the building structure and shall be compatible thereto. All such anchorage shall be reviewed by the project's structural engineer.

K. Review of the seismic design and shop drawings by the Engineer/Architect or his agent shall not relieve the Mechanical Contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code.

15622 PIPE AND PIPE FITTINGS:

General - Run all piping parallel or perpendicular to building lines and walls unless otherwise shown. Exposed piping arrangements shall be symmetrical straight runs, evenly spaced and graded.

A. PIPING:

1. Piping For A/C Condensate Water Lines: Pipe: A/C condensate pipe shall be "Cresline" PVC, schedule 40, or approved equal, conforming to ASTM Specification D1785-13, suitable for a minimum working pressure of 150 PSI, with water temperature of 120 degrees F. Pipe shall be furnished with couplings and PVC schedule 40 pressure fittings for cement joints. Adapter fittings with screw connections shall be furnished as required for connections to equipment, valves, unions, etc. Joints to be assembled in accordance with manufacturer's recommendations and instructions. Piping shall be adequately supported with hangers spaced in accordance with manufacturer's instructions and recommendations.

All pipe shall be clearly marked with class, specification designation, and pressure rating.

Where condensate piping passes thru rated assemblies, insulated copper piping will be allowed.

3. Gas Piping: Furnish and install gas piping system for use of natural gas or propane gas (refer to drawings) complete in all respects and in compliance with American Standard ASA B 36-10-1959.

Piping and fittings within the building shall be black steel, Schedule 40. Fittings shall be black malleable iron screw type class 150 fittings. Piping below grade shall be installed in conduit-split terra cotta or PVC-DWV drainage pipe, and vented where required.

Piping and fittings outside the building shall be black steel with an approved corrosion resistant coating material. All underground piping to be welded and pipe coated with corrosion prohibitive compound or tape. All interior piping to be painted yellow.

Installation shall be in conformance with NFPA standard No. 54 and North Carolina State Code. Provide shut-off at each branch take-off and at each equipment connection location.

Gas meter (or tank) location, all piping, and installation to be in accordance with the local gas company standard procedures, rules and regulations.

When the gas supply pressure is higher than that at which the branch supply line or gas utilization equipment is designed to operate or varies beyond design pressure limits, a line gas pressure regulator or gas equipment pressure regulator, as applicable, shall be installed by this Contractor.

Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors. A means shall be employed to prevent water from entering this piping and also to prevent stoppage of it by insects and foreign matter.

All cost and fees for bringing gas service to building to be paid by this Contractor.

B. Testing: All piping installations shall be tested at a hydrostatic pressure of 125 p.s.i. and proven tight, to the satisfaction of the Designer. Threaded joints with leaks which cannot be stopped by tightening shall be dismantled and

remade. No caulking of joints will be allowed. Designer shall be given advance notice of time tests are to be made so a representative may be present to observe.

C. Grading and Venting: All piping shall be installed with drain valves at low points to allow complete drainage of all parts of system. Grade all pipes up approximately one inch in twenty feet in direction of flow. On water systems, install manual valved air vents at all high points in system where air pockets may occur, allowing complete purging of systems of air, and where applicable piping to and valving at accessible location.

D. Joints: Joints in piping 2" and under in size may be threaded or welded at the Contractor's option. All joints in pipes 2-1/2" and larger shall be welded, except that all joints in underground pipes shall be welded regardless of size.

E. Fittings: Fittings for screwed joints shall be close grained grey cast iron or malleable iron good for 125 p.s.i. working pressure, tapped with true full threads.

F. Threaded Joints: Threaded joints shall be made up with a thin mixture of oil and graphite, or Rutland joint compound, applied to the male thread only, taking care not to allow excess graphite to work into pipe and wiping clean the surface of the pipe after joint is completed. All threaded pipe shall be thoroughly reamed after cutting.

Oil and graphite shall also be applied to flange bolts or other fabricated work where future dismantling may be required.

G. Reducing Fittings shall be used where pipe size changes are made. No bushings will be allowed. Eccentric reducers shall be used where steam or water circulating lines are reduced in size. Straight side of reducers to be located at bottom of steam lines and at top of water lines.

H. Flanges and companion flanges in welding lines shall be welding neck type, ASTM A181-55T, Grade 1. All other flanges shall be standard weight screwed type unless otherwise noted, same grade as welding flanges. Bolts for flanges shall be correct sizes and lengths and fitted with hex nuts. Bolts shall extend through flanges with not more than 1/4" of extra thread exposed. Gaskets of appropriate material for service shall be installed between flanges.

I. Valves shall be same size as pipe line in which they occur unless otherwise noted.

J. Unions shall be used where necessary to disconnect pipe for future servicing or repairs and at all connections to equipment. Unions in screwed ferrous pipe shall be malleable iron with bronze seats and ground ;joints. Dielectric unions shall be used for all connections of dissimilar metals. Unions in welded pipes shall be flanged as specified elsewhere.

K. Gaskets: Gaskets for flanged connections in water lines shall be machine cut, ring type, cut from 1/8" thick red cloth imbedded rubber or neoprene good for 125 p.s.i. service of correct size for flanges.

M.. Welding to be by the Metal Arc Welding Process and in general conformance with procedures established in the latest edition of Appendix B to Section 6 of the ASA Code for Pressure Piping B 31.1

Operators who are to do the welding must be properly qualified to do satisfactory work. Proof of an operator's qualifications shall be either this Contractor's record of suitable tests passed within the preceding three months while in the employment of this Contractor, or tests made before the start of the work. Any workman considered by the Architect/Engineer as not having the skill necessary for the work shall be required to pass an appropriate qualification tests or shall be at once barred from further welding on the job.

Joints shall be properly beveled, thoroughly cleaned of rust or other foreign matter, before welding. Joints shall be separated sufficiently for easy fusion of the weld metal with the bottom of the vee, and shall be tackwelded in two or more places to maintain proper alignment.

All welding shall be continuous around the joint. Weld metal shall be deposited in such a manner that the sides and bottom of the surface or edges joined are thoroughly fused, with surface of the weld having proper reinforcement and width.

During erection care shall be taken to remove all dirt, scale and other foreign matter from inside the piping before tying in long sections o installing valves.

All welded piping shall be subjected to a hydrostatic test of 1-1/2 times the working pressure, or at least 125 psig., at which pressure all welded joints shall be hammered with a 3# hammer, blows being struck with sufficient force to jar the pipe and the joint, but not so hard as to injure the pipe. All welds shall satisfactorily pass this test without showing leaks or any defects. Designer shall be given advance notice of times tests are to be made, so a representative may be present to observe.

Pinhole leaks which may develop as a result of the test shall be repaired by welding. Welds which show general sweating or continuity of pinholes shall be replaced.

Welding fittings shall be used with welded piping. These shall be welding pattern, Tube Turns, Taylor Forge, Landish, or equal. Such fittings shall be provided at all changes in direction, or changes in pipe size except as hereinafter provided.

Weldolet or Threadolet fittings may be used in lieu of welded fittings for branch connection to size 2" and larger mains, provided branch is two or more pipe sizes smaller than the main.

15624 PIPING SPECIALTIES:

A. Hangers and Supports:

All piping shall be supported from the building structure. Refer to structural drawings, details and/or the designer as applicable.

Pipe hanger shall be supported by means of iron hanger rods from the building construction. Where shown on the plans, or where required, piping shall be hung from angle iron clips or suitable brackets attached to sides of masonry construction similar to Grinnell Fig. 195. Where piping is hung from bar joists, angle iron supports shall be welded to joists (at least three) and hanger rod attached to supporting angle, as directed by the Designer. Angle iron provided by Mechanical Contractor.

Hanger rods shall have machine threads and be sized according to manufacturer's recommendations.

Support spacing shall be a minimum of:

Pipes 1" and smaller - 8'-0" centers maximum

Pipes 1 1/4" and larger - 10'-0" centers maximum

Support pipes at all changes in direction

All suspended piping shall be supported by means of wrought iron hanger rings or adjustable clevis hangers and iron hanger rods. Hangers shall be sized for the outside diameter of the insulation for piping that is insulated.

Piping shall be hung by means of clevis type hangers similar to Grinnell Fig. 260. In spaces where indicated or where required due to limited space, Grinnell #171 shall be used. Alternately, a rack type piping support system may be used similar to Unistrut pipe clamps complete with appropriate insulating and mounting hardware.

Hangers for uninsulated copper piping shall be Grinnell Fig. 97-CT.

All miscellaneous metal required for supporting pipe work, including steel supports, angles between joists, anchors, inserts, bracing, bolts, nuts, washers, etc shall be supplied and installed by this Contractor. All miscellaneous metal shall be painted.

Hanging arrangements shall be subject to approval of Designer.

All insulated piping shall be provided with insulation protection sheet metal saddles. These shall be No. 16 gauge galvanized iron. Saddles shall be of length equal to two times the outside diameter of the insulation and shall extend to above center lines of the pipe.

B. Pipe Sleeves:

Where pipes pass through floors or walls, provide standard weight, Schedule 40, steel pipe sleeves, finishing flush with wall surfaces and extending 1/2" above finish floors. Sleeves for insulated pipes shall be of sufficient size to allow passage of insulation. All sleeve openings to be appropriately sealed at completion of construction, with a U.L. listed fire barrier; Dow Corning 3-6548 silicon RTV foam, "3M" CP25 caulk or 303 putty, T & B "Flame Safe", or approved equal. Sleeves through floors shall have concrete curb poured surrounding sleeve.

C. Floor and Ceiling Plates:

Where pipes or hanger rods pass through floors, walls or ceilings in finished areas, provide chrome-plated spring type steel escutcheon of approved design for neat application and of adequate size to cover sleeve openings as manufactured by Kenney, Connecticut Stamping and Bending Company, Dearborne or approved equal.

15629 PIPE INSULATION:

All piping shall be insulated, including all accessories, fittings, valves, and etc.

A/C condensate PVC piping does not require insulation. A/C copper piping shall have ¾" Armaflex (flexible elastomeric) insulation – installed per manufacturer's installation instructions. Outdoor insulation shall be protected with pvc, u.v. resistant jacketing – color to match building.

15630 ELECTRIC MOTORS:

Motors shall be high efficiency type of sufficient size for the duty to be performed and shall not exceed their full rated load when the driven equipment is operated at specified capacity under the most severe conditions likely to be encountered. Motors shall have continuous duty classification based on 40 C ambient temperature or reference. Minimum motor efficiencies shall be in accordance with N.C. Mechanical Code, and ASHRAE 90.

Motors 1/3 HP or smaller shall be wired to single phase, 120 volt power; motors 1/2 HP or larger shall be wired for 3-phase power. All 3-phase motors to be rated in accordance with latest NEMA standards. Shaded pole motors larger than 1/20 HP will not be permitted. Motors 2 HP or larger shall have grease lubricated ball bearings.

Provide starters with H-O-A switches mounted in door and proper overload elements for all motors furnished and installed under this contract, including single phasing protection. Switches and controls shall be located for convenient access and use if not specifically located on drawings.

15732 PACKAGED ROOF OR GROUND-MOUNTED AIR-TEMPERING UNIT:

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Package roof top unit.

B. Heat exchanger.

C. Refrigeration components.

D. Unit operating controls.

E. Roof curb.

F. Electrical power connections.

G. Operation and maintenance service.

1.02 RELATED SECTIONS

A. Section 15170 - Motors.

B. Section 15242 - Vibration Isolation.

C. Section 15290 - Ductwork Insulation.

D. Section 15885 - Air Cleaning.

E. Section 15952 - Controls and Instrumentation.

F. Section 16180 - Equipment Wiring Systems.

1.03 REFERENCES

A. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.

B. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. AHRI 360 - Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard.

D. ANSI/ASHRAE 37 - Testing Unitary Air Conditioning and Heat Pump Equipment.

E. ANSI/ASHRAE/IESNA 90.1-1999 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.

F. ANSI Z21.47/UL1995 - Unitary Air Conditioning Standard for safety requirements.

G. AHRI 210/240 - Unitary Air-Conditioning Equipment and Air- Source Heat Pump Equipment.

H. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

I. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.

J. ANSI/NFPA 70-1995 - National Electric Code.

1.04 SUBMITTALS

A. Submit unit performance data including: capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

E. Shop drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.

1.05 DELIVERY, STORAGE and HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.06 WARRANTY

A. Provide parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five year extended warranty for compressors.

C. Provide five-year heat exchanger limited warranty.

1.07 REGULATORY REQUIREMENTS

A. Unit shall conform to ANSI Z21.47/UL1995 for construction of packaged air conditioner<<ANSI_Z21.47/UL_1995_REQUIREMENTS3>>

1. In the event the unit is not UL approved, the manufacturer must, at his expense, provide for a field inspection by a UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative, at no additional expense to the Owner.

PART 2 PRODUCTS

2.01 SUMMARY

A. The contractor shall furnish and install package rooftop unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. APPROVED MANUFACTURERS

1. Trane is the basis of design. Approved equivalent products by Carrier, Johnson, and Daikin. **Alternate #M1 – Owner preferred brand of equipment to be by Trane (only) – for standardization.**

2. Substitutions: [10 working days prior approval required] as indicated under the general and/or supplemental conditions of these specifications. Mechanical contractor shall be responsible for

electrical and mechanical changes to the structure when using a product other than the specified product. As built drawing changes are the responsibility of the mechanical contractor. [In California, the contractor is responsible for resubmittal under Title 20 of California Law.]

2.02 GENERAL UNIT DESCRIPTION

A. Unit(s) shall be 100% factory run tested and fully charged with R-410A

B. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

C. Units shall be dedicated downflow or dedicated horizontal airflow as manufactured.

D. Wiring internal to the unit shall be colored and numbered for identification.

2.03 UNIT CASING

A. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating with removable access panels. Structural members shall be 16 gauge with access doors and removable panels of minimum 20 gauge.

B. Units cabinet surface shall be tested 1000 hours in salt spray test in compliance with ASTM B117.

C. Cabinet construction shall allow for all service/ maintenance from one side of the unit.

D. Cabinet top cover shall be one piece construction or where seams exits, it shall be double-hemmed and gasket-sealed.

E. Access Panels: Water- and air-tight panels with handles shall provide access to filters, heating section, return air fan section, supply air fan section, evaporator coil section, and unit control section.

F. Downflow unit's base pans shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.

G. Insulation: Provide 1/2 inch thick coated fiberglass insulation on all exterior panels in contact with the return and conditioned air stream.

H. Provide openings either on side of unit or thru the base for power, control and gas connections.

I. The base of the unit shall have provisions for forklift and crane lifting

2.04 AIR FILTERS

A. 2" Pleated Filters - Unit shall be provided with two inch MERV 13 filters with filter removal tool as standard on all products.

2.05 FANS AND MOTORS

A. Provide evaporator fan section with forward curved, double width, double inlet, centrifugal type fan.

B. Provide self-aligning, grease lubricated, ball or sleeve bearings with permanent lubrication fittings.

C. Provide units 12 1/2 tons and above with belt driven, supply fans with adjustable motor sheaves.

D. Outdoor and Indoor Fan shall be permanently lubricated and have internal thermal overload protection.

E. Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position.

F. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

2.06 GAS FIRED HEATING SECTION

A. Completely assembled and factory installed heating system shall be integral to unit, UL or CSA approved specifically for outdoor applications for use downstream from refrigerant cooling coils. Threaded connection with plug or cap provided.

B. Heating section shall be factory run tested prior to shipment.

C. Gas Burner shall be forced combustion type power burner, negative pressure gas valve, manual shut-off, hot surface ignition, and flame sensing safety control.

D. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, and continuous flame supervision. Upon a failure to ignite, two attempts of ignition will occur before lockout of the ignition system.

E. Combustion blower shall be centrifugal type fan with built- in thermal overload protection on fan motor.

F. Heat Exchanger: Provide drum and tube heat exchanger of free floating design manufactured from 18-gauge aluminized steel, factory pressure and leak tested.

G. Limit controls: High temperature limit controls will shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow or loss of indoor airflow.

2.07 EVAPORATOR COIL

A. Provide configured aluminum fin surface mechanically bonded to copper tubing coil.

B. Provide an independent expansion device for each refrigeration circuit. Factory pressure test at 450 psig and leak test at 200 psig.

C. Provide drain pan for base of evaporator coil constructed of PVC or galvanized steel with external connections.

2.08 CONDENSER SECTION

A. Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.

2.09 REFRIGERATION SYSTEM

A. Compressor(s): Provide scroll compressor with direct drive operating at 3600 rpm. Integral centrifugal oil pump. Provide suction gas cooled motor with winding temperature limits and compressor overloads.

B. Units shall have cooling capabilities down to 0-degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.

C. Provide each unit with 2 refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, suction and liquid line pressure ports.

2.10 OUTDOOR AIR SECTION

A. Provide economizer with dry bulb control

B. Provide adjustable minimum position control located in the economizer section of the unit.

C. Provide spring return motor for outside air damper closure during unit shutdown or power interruption.

D. Provide CO2 sensor for control of outside air.

2.11 OPERATING CONTROLS

A. Provide factory-wired roof top units with 24 volt control circuit with control transformers, contactor pressure lugs or terminal block for power wiring. Contractor to provide Disconnect. Units shall have single point power connections. Field wiring of zone controls to be NEC Class II.

B. Provide microprocessor unit-mounted control which when used with an electronic zone sensor provides proportional integral room control. This UCM shall perform all unit functions by making all heating, cooling and ventilating decisions through resident software logic.

C. Provide factory-installed indoor evaporator defrost control to prevent compressor slugging by

interrupting compressor operation.

D. Provide an anti-cycle timing and minimum on/off between stages timing in the microprocessor.

E. Economizer Preferred Cooling (if supplied with economizer) - Compressor operation is integrated with economizer cycle to allow mechanical cooling when economizer is not adequate to satisfy zone requirements. Compressors are enabled if space temperature is recovering to cooling setpoint at a rate of less than 0.2 degrees per minute. Compressor low ambient lockout overrides this function.

2.12 BUILDING MANAGEMENT SYSTEM

A. Interface control module to (future) Energy Management System to be furnished and mounted by rooftop unit manufacturer. Through this interface module, all Energy Management functions (specified in Energy Management Section) shall be performed. The interface is to be connected to BAS for this project. All points shall be integrated to BAS to provide full monitoring, setpoint adjustment (temp., economizer, etc.), operating schedule adjustment (on/off), etc. Fully functionality shall be possible via BAS or via local control. Provide all BAS interface modules, parts, etc. as required for a complete installation. Interface shall be Bacnet compatible. Tie-In to the BAS shall be future

PART 3 EXECUTION

3.01 EXAMINATION

A. Contractor shall verify that roof is ready to receive work and opening dimensions are adequate.

B. Contractor shall verify that proper power supply is available.

3.02 INSTALLATION

A. Contractor shall install in accordance with manufacturer's instructions.

B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork

and utility services. Install roof mounting curb level.

PART 4 SEQUENCE OF OPERATIONS

4.01 PACKAGED ROOFTOP UNITS (RTU)

A. Microprocessor controller - Each RTU shall be controlled by a stand-alone microprocessor based controller with resident control logic. The controller will interface with the BAS and the inputs and outputs in the points list to accomplish the following temperature control and energy conservation strategies.

1. Occupied Mode - All unit functions will be enabled for normal heating and cooling operation. Unit defaults to default temperature setpoints in the unit microprocessor when communication with BAS is lost.

2. Occupied Space Temperature Control - When in occupied mode as described above, the dedicated unit control shall operate stages of heating and cooling to maintian space temperature setpoint. Setpoints may be set by one of the following methods:

   a. Remotely through BAS by the system operator;

   b. Locally through the thermostat by the occupant;

   c. Locally through the thermostat by the occupant within limits defined through the BAS by the system operator;

   d. Operator may designate wild card setpoints to apply to any or all of the RTU's through the BAS.

B. Optimal Start Mode - When the unit is turned on by the BAS for optimal start, heating or cooling is provided as required. The outside air dampers, if provided, remains closed, in heating mode or mechanical cooling mode, until occupied time. Economizer cycle, if supplied, will be available if

required.

C. Coastdown Mode - When the unit is turned "OFF" by the BAS for optimal stop, the supply fan remains "ON/AUTO", the outside air damper remains in minimum position for ventilation, and utilizes the unoccupied setpoints.

D. Demand Limit Mode - Through the BAS a user defined Demand Limit Mode shall be available. User defines maximum off time and temperature to ensure occupant comfort.

E. Night Setback Temperature Control - When the BAS selects unoccupied mode, the unit shall be controlled to maintain user defined unoccupied heating and cooling setpoints. Adjustable start and stop temperature differentials will prevent short cycling. The outdoor air damper remains closed during heating night setback operation, if provided.

F. Economizer - Each RTU when equipped will measure dry bulb temp and select lowest total heat air stream to meet cooling demands. When using return air, the outside air damper will be position at a minimum position. The minimum position will be adjustable by the operator or through the BAS software.

G. Nighttime Free-Cool Purge Mode - An "economizer only" cooling cycle shall be provided during unoccupied hours when outdoor air conditions are suitable and the zone requires cooling.

H. Low Ambient Compressor Lockout - Compressor operation shall be disabled below a user defined outdoor air temperature.

I. Timed Override - When a timed override is initiated by the user, the unit will return to its user defined normal occupied mode for the user determined period of time.

J. Fire Shutdown - The unit will shut down in response to a customer supplied contact closure to the BAS indicating the presence of a fire or other emergency condition.

K. Unit status report - For each RTU unit, the BAS shall provide an operating status summary of all sensed values (zone temperature, discharge temperature, etc.) setpoints and modes.

L. Supply Air Tempering - When the unit is in the heat mode, but not actively heating, if the supply air temperature drops 10 degrees or more below the heating setpoint, heat is turned on until supply air temperature rises to a point 10 degrees above the heating setpoint.

M. Alternating Lead/Lag - (Dual Compressors Models Only), During periods of part load operation, each compressor cycles alternatively as circuit circuit number one in order to equalize wear and run time.

N. Economizer Preferred Cooling - Compressor operation is integrated with economizer cycle to allow mechanical cooling when economizer is not adequate to satisfy zone requirements. Compressors are enabled if space temperature is recovering to cooling setpoint at a rate of less than 0.2 degrees pe rminute. Compressor low ambient lockout overrides this function.

O. Diagnostic/Protection - The BAS system shall be able to alarm from all sensed points from the rooftop units and diagnostic alarms sensed by the unit controller. Alarm limits shall be designated for all sensed points.

15764 DUCT WORK:

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.

2. Round ducts and fittings.

3. Sheet metal materials.

4. Sealants and gaskets.

5. Hangers and supports.

6. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

2.2 PERFORMANCE REQUIREMENTS

A. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.

B. Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:

1. HVAC Duct Construction Standards, Metal and Flexible, 2nd Edition, 1995

2. HVAC Air Duct Leakage Test Manual, 1st Edition, 1985

3. HVAC Systems - Duct Design, 3rd Edition, 1990

4. Rectangular Industrial Duct Construction Standard, 1st Edition, 1980

5. Round Industrial Duct Construction Standards, 2nd Edition, 1999

6. Thermoplastic Duct (PVC) Construction Manual, 2nd Edition, 1995

7. Round Industrial Duct Construction Standards, 2nd Edition, 1999

8. Rectangular Industrial Duct Construction Standards, 1st Edition, 1980

C. Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

3.2 SUBMITTALS

A. Include manufacturer's data and/or Contractor data for the following:

1. Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.

2. Duct sealant and gasket material.

3. Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

A. Welding certificates.

7.2 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PRODUCTS

9.2 GENERAL

A. All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12” and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2nd Edition, 1995.

B. Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

9.3 DUCTWORK PRESSURE CLASS

A. Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes not indicated on the drawings to be as follows:

Supply duct upstream of VAV boxes	_____ 3”-4” S.P.	___4” pressure class
Supply duct downstream of VAV terminals	1”-2” S.P.	___2” pressure class
Transfer ducts	_____ ½”-1” S.P.	_____ 1” pressure class
Exhaust ducts	_____ 1”-2” S.P.	_____ 2” pressure class
Return ducts	_____ 1”–2” S.P.	_____ 2” pressure class
Relief ducts	_____ 1”-2” S.P.	_____ 2” pressure class
Constant Volume AHU Supply	_____ 2”-3” S.P.	_____ 3” pressure class
Grease Hood Exhaust	_____ 2”-3” S.P.	_____ 3” pressure class
**Smoke Exhaust System	_____ 3”-4” S.P.	_____ 4” pressure class

**Note: All ductwork that serves a dual function (i.e. return / relief and smoke exhaust (for example)) shall be constructed to the highest pressure requirement. All ductwork that is part of the smoke exhaust system shall be constructed to the listed classification for smoke exhaust ductwork. Care should be taken in this determination to avoid field replacement of duct sections.

9.4 MATERIALS

A. Galvanized Steel Sheet: Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90.

B. Uncoated Black Steel Sheet: First quality, soft steel sheet capable of welding or double seaming without fracture.

C. Aluminum Sheet: Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture.

D. Stainless Steel Sheet: Use ASTM A167, Type 304 or 316 stainless steel sheet as specified, 316L if welded ductwork, with No. 2B finish for concealed work and No. 3 finish for exposed work.

E. Polyvinylchloride Coated Steel Sheet: Use hot-dipped galvanized steel sheet with prime coat and a polyvinyl chloride film on both sides. Thickness of coating to be a minimum of 4 mils on each side. United Sheet Metal Uni-Coat, made by United McGill Co., may be used at contractor's option.

1. Where any duct surface is scratched, marred, or otherwise damaged, paint with PVC aerosol spray.

2. All couplings shall be slip-joint construction with a minimum 2 inches insertion length. Seal all couplings with sealants as specified.

9.5 HIGH PRESSURE DUCTWORK (Pressure class 3 inch and over)

A. Manufacturers: Ajax, Semco, United Sheet Metal, or approved equal.

B. Machine formed round and/or flat oval spiral lock seam duct constructed of galvanized steel.

~~C.~~ Rectangular high pressure duct using a transverse joint system as manufactured by Ductmate, Nexus, TDC, TDF, or approved equal, may be used at contractor's option. Duct to be flanged, gasketed and sealed.

D. Contractor fabricated ductwork meeting specified construction standards is acceptable with prior approval of Architect/Engineer. Submit construction details, a description of materials to be used, type of service, reinforcing methods, and sealing procedures.

E. Use a perforated inner liner on double wall high-pressure duct. Annular space between inner liner and outer duct to be filled with 1 inch glass fiber insulation.

F. Use cemented slip joints with 2 inch minimum overlap, flanged connections, or welded/brazed connections, unless noted otherwise for special applications. Prime coat welded joints.

G. Provide standard 90 degree conical tee takeoffs except for exhaust at velocities over 2000 feet per minute, use 45° lateral connections; straight taps or bullhead tees are not acceptable.

H. Internal bracing will not be accepted on ductwork below 48 inches.

I. Use turning vanes as specified in Section 23 33 12.

J. Provide bellmouth fittings or expanded fittings at each duct connection to air plenums.

K. Provide pressure relief fittings as indicated on the plans and/or details.

L. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

9.6 LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)

A. Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.

B. Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.

C. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.

D. Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.

E. Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.

F. Button punch snaplock construction will not be accepted on aluminum ductwork.

G. Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts, with approval of Engineer. No variation of duct configuration or sizes permitted except by written permission of the Architect/Engineer.

H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

9.7 DUCT SEALANT

A. Manufacturer: 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal. Silicone sealants are not allowed in any type of ductwork installation.

B. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

9.8 GASKETS

A. 2 inch pressure class and lower: Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

B. 3 inch pressure class and higher: Butyl gaskets.

C. FUME HOOD EXHAUST; Butyl gaskets.

EXECUTION

9.9 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved by Designer prior to fabrication.

B. Take field measurements to verify duct routing and coordination with all trades prior to fabrication.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Install round ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." All ductwork open ends to be capped during the course of construction.

N. Owner and / or owner's representative shall be notified a minimum of 24 hours in advance of any duct pressure testing. Results of duct pressure testing shall be forwarded to the owner / engineer

for approval and included in the final test and balance report. All ductwork shall be pressure tested per recommendations in SMACNA.

10.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

B. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."

11.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

1. Do not use powder-actuated concrete fasteners for seismic restraints.

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

13.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" and requirements of Delegated Design in Division 23 Section "Vibration and Seismic Controls for HVAC."

14.1 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

15.2 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

1. Moist Environment Ducts: Aluminum.

Commercial Kitchen Hood Exhaust Ducts: Comply with NFPA 96.

Exposed to View: Type 304, stainless-steel sheet, **No. 4 finish**.

Concealed: **Type 304, stainless-steel sheet, No. 2D finish**.

Welded seams and joints.

Dishwasher Hood Exhaust Ducts:

Type 304, stainless-steel sheet.

Exposed to View: **No. 4 finish**.

Concealed: **No. 2D finish**.

Welded seams and flanged joints with watertight EPDM gaskets.

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Stainless-Steel Ducts: Galvanized steel.

3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.

2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.

b. Velocity 1000 to 1500 fpm: Conical tap.

c. Velocity 1500 fpm or Higher: 45-degree lateral.

15765 AIR DUCT ACCESSORIES:

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.

2. Manual volume dampers.

3. Control dampers.

4. Fire dampers.

5. Smoke dampers.

6. Flange connectors.

7. Turning vanes.

8. Duct-mounted access doors.

9. Flexible connectors.

10. Flexible ducts.

11. Duct accessory hardware.

1.2 SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control damper installations.

d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.

e. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

A. Manufacturers: Ruskin, Vent Products, Air Balance, or approved equal.

B. Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.

C. Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

2.2 TURNING VANES

A. Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.

B. Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 2-3 and Fig. 2-4 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 2-5 and Fig. 2-6.

2.3 FIRE DAMPERS

A. Manufacturers: Air Balance, Advanced Air, American Warming and Ventilating, Greenheck, Phillips-Aire, Prefco, Ruskin, Safe-Air or approved equal.

B. STATIC FIRE DAMPERS

1. Static fire damper assemblies must be UL 555 (6th edition) listed and labeled for static applications (where air systems do not operate during a fire) and meet requirements of NFPA 90A. Damper must be type B curtain type with blades out of the air stream; dampers with blades in the air stream will not be accepted. Damper fire rating to be compatible with the rating of the building assembly in which the damper is used.

C. DYNAMIC FIRE DAMPERS

1. Dynamic fire damper assemblies must be UL 555 (6th edition) listed and labeled for dynamic applications (where air systems operate during a fire) and meet requirements of NFPA 90A. Dampers must be type B curtain type with curtain 100% out of air stream. Dampers larger than 30” by 30” or with velocity rating requirements of 3000 fpm or higher, may be multiblade type with blades located in the airstream. Velocity ratings and static pressure ratings as indicated on the drawings. Damper fire rating to be compatible with the rating of the building assembly in which the damper is used.

2.4 SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Manufacturers: Ruskin, Johnson Controls, Air Balance, Advanced Air, American Warming and Ventilating, Greenheck, Safe-Air, Phillips-Aire, Prefco, or approved equal.

B. Smoke damper assemblies to be UL 555S(4th edition) listed and labeled, and leakage rated at no higher than Class II under UL 555S(4th edition). Unless ratings are indicated elsewhere, dampers should be rated for minimum 2,000 fpm air velocity and 4" static pressure.

C. Combination fire/smoke damper assemblies to be UL 555(6th edition) and UL 555S(4th edition) listed and labeled, and have a fire rating compatible with the rating of the building assembly in which the damper is used, and be leakage rated at no higher than Class II under UL 555S.

D. Provide factory installed electrically operated dampers with linkage arranged so that the damper is closed on loss of power. For electric actuation, provide electric operated dampers with linkage and UL listed operators arranged so that the damper is closed on a loss of power. Where electric actuation is controlled by the DDC system use 0-10 VDC inputs, with stall protection, and with and zero and span adjustments for modulating or 24 VAC for two-position control. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Locate all operators out of the air stream unless large damper size will not allow. Provide form "C" end switches to indicate damper position.

E. Use airfoil shaped damper blades on the following systems where the duct velocity is above 2000 fpm (coordinate with metal duct specifications, duct drawings / submittals, etc.).

2.5 ACCESS DOORS

A. Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall

access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted. Access doors to have minimum size of 12”x6”. All fire dampers, smoke dampers, and combination fire / smoke dampers shall be capable of being operated / reset / observed via duct access door(s) or have other means available to do so.

B. Use insulated, 1-1/2 hour UL 555 listed and labeled access doors in kitchen exhaust ducts.

2.6 FLEXIBLE DUCT

A. Manufacturers: Anco Products, Clevaflex, Thermaflex, Flexmaster or approved equal.

B. Factory fabricated , UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and a smoke developed rating of 50 or under in accordance with NFPA 90A.

C. Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.

D. Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.

E. Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

2.7 DUCT LINING (No Duct Liner Allowed – This Project)

2.8 DUCT FLEXIBLE CONNECTIONS

A. Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

B. Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.

C. Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon¿,air and water tight, suitable for temperatures between -10°F and 250°F, and have a nominal wight of 26 ounces per square yard.

D. For corrosive environments or fume exhaust applications indoors or outdoors, use a material coated with Teflon that is air and water tight, suitable for temperatures between -20°F and 500°F, and has a nominal weight of 14 ounces per square yard.

2.9 SOUND ATTENUATORS

A. Manufacturers: Industrial Acoustics Company, Environmental Elements Corporation, Semco, Dynasonics, United McGill, Rink, or approved equal.

B. Construct of a 22 gauge galvanized steel outer casing, and 26 gauge galvanized, perforated steel inner liner. Seams and joints of outer casing to be air tight.

C. Fill annular space between outer casing and inner liner with acoustic fill that is inert, inorganic, and of a density sufficient to obtain the specified acoustic performance. Material must meet requirements of NFPA 90A with a flame spread index of 25 or less and smoke developed rating of 50 or less.

D. Acoustical and aerodynamic performance is indicated on schedules on the drawings.

2.10 HOODS FOR INTAKE AND EXHAUST

A. Manufacturers: Acme, Ammerman, Carnes, Cook, Greenheck, Louvers and Dampers, Penn, or approved equal.

B. Use low silhouette type hoods or louvered penthouse type hoods with drainable blade louvers, as shown on drawings.

C. Construct hoods of aluminum (mill finish) or galvanized steel with a baked enamel finish; color to be selected by the Architect during the submittal stage.

D. For hoods and louvered penthouses maintain minimum 30 inches from bottom of air intake to finished roof.

E. Provide accessories as shown on drawings.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Downstream from manual volume dampers, control dampers, and equipment.

3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

4. At each change in direction and at maximum 50-foot spacing.

5. Upstream of turning vanes.

6. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.

2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.

5. Body Access: 25 by 14 inches.

6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to low-pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

Q. Install duct test holes where required for testing and balancing purposes.

R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

15766 HANGERS AND SUPPORTS:

Horizontal rectangular ducts shall be supported by hangers as follows:

Duct Size-Long Dim.	Hanger Size & Type	Maximum Spacing
60" or less	1" x 18 gauge	8'-0"
61" and over	3/8" dia. rod	8'-0"

Bands shall be bent over one inch from end and turned under the corners of rectangular ducts and fastened with self-tapping screws at corners and at 6" intervals up the sides. Rod hangers shall be secured to bottom bracing angles with nuts and lock nuts. Hanger material shall be galvanized steel, 1" minimum 16 gage.

Upper ends of hangers shall be secured to floor or roof construction above by a method which will develop the full strength of band or rod.

Duct system shall be supported at all turns and transitions and at not more than 6 feet on center for ducts up to 24 in. maximum dimension.

All round ducts shall be supported by hangers 1" minimum width of 16 gauge galvanized strap, or rods. Hangers shall be attached to ducts with self tapping sheet metal screws, pop rivets, or nuts and lock nuts. Upper ends of hangers shall be secured to floor or structural member above by a method which will develop the full strength of band or rod.

This contractor shall furnish and install all miscellaneous metal required for the proper hanging of duct work.

15770 GRILLES AND DIFFUSERS:

Furnish and install ceiling diffusers, supply and return air and exhaust grilles and registers as noted on plans and in schedules. Provide all volume control and adjusting devices as called for in schedules, all supply diffusers shall be equipped with volume controls. Grills, registers and diffusers shall be as manufactured by Metal Industries, Carnes, Titus, EH Price, Tuttle & Bailey, Nailor Industries, or approved equal. Round neck adapters are to be provided where required.

Unit offered as substitutes to those used in the layout of the system shall show suitable air distribution and performance. Final approval will be reserved, pending satisfactory performance on job.

Ceiling diffusers to be lay-in or surface mounted as ceiling type dictates. Finish to be off white baked enamel.

15810 DUCT INSULATION

All supply, make-up and return ducts to be insulated unless noted otherwise on drawings. All ductwork routed in unconditioned spaces shall have 2" blanket insulation, or 1" duct liner as outlined below.

Insulation required for conditioned air ducts shall be as listed below:

A. EXPOSED DUCT:

Exposed supply, return, and make-up (o/a) duct within equipment rooms shall be wrapped with 2” ductwrap. Exposed spiral or rectangular supply or return ductwork in the area served by the ducts, shall be un-insulated, unless noted

otherwise on drawings or in ductwork specifications. Exposed, outdoor ductwork to be insulated as described on drawing details.

B. CONCEALED DUCTS:

Rectangular supply, return, and fresh air make-up ducts concealed in ceiling spaces within building envelope shall have 2” duct wrap. All round supply and return metal ductwork to be insulated with 2" ductwrap.

Exhaust Ducts shall be un-insulated.

C. BLANKET INSULATION:

Blanket type insulation shall be 3/4 lb. density fiberglass having a vapor barrier jacket of .002 inch high aluminum foil laminated and reinforced with paper or glass fibers (minimum R = 6.5).

Vapor barrier jacket shall be overlapped not less than 2 inches at all joints by cutting back insulation and lapping jacket to form a smooth tight joint scaled and cemented down with a suitable noncombustible adhesive. Insulation shall be secured to ducts with weld pins or metal stick clips and speed washers spaced at not over 12" o.c. each way.

15822 AUTOMATIC TEMPERATURE CONTROLS:

Furnish and install a complete system of electric temperature controls as specified herein. Controls shall generally be packaged, programmable controls with the ability to interface with facility ems in the future (i.e. BacNet cards or BacNet Thermostats (where applicable) shall be included for full unit integration of all control / programming / monitoring "points" in the future). Replacement parts for all control components shall be kept in stock locally.

Generally all equipment to be furnished with packaged, standalone controls per schedules and information on drawings (programmable thermostats, control dampers, packaged interface equipment / modules). Packaged equipment to generally be for standalone operation (i.e. no interface to a building energy management system). Mechanical Contractor shall be responsible for setup and programming of all controls per manufacturer's recommendations. In addition to packaged controllers, t'stats / sensors, etc. at all equipment, BACNET cards for and controls for future integration of all equipment to owner's energy management system. Local Packaged Controls Systems to be accessed via factory packaged keypads, or interface devices – coordinate mounting locations / access with owner. Controls to be by Trane, or approved equals by Carrier, Johnson or Daikin. All packaged controls, devices, etc. to be full programmed by this contractor. Occupancy schedules to be coordinated with the Owner.

Provide solid state heating - cooling auto-changeover, 7-day programmable thermostats for space temperature control for fan coil split systems. Thermostats to have dual setpoints (heating / cooling).

Thermostats shall be equipped with switches to provide for continuous fan operation, or Auto fan operation and system Off-Heat-Cool-Auto, and be compatible with equipment furnished. Fan shall run continuously for all rtu's during "occupied" periods.

Program control for designated toilet exhaust fans to be via associated zone programmable thermostat (wired – in at auxiliary contact(s)).

Packaged digital controllers to be provided for all miscellaneous exhaust systems, and all other equipment as required.

Any control devices shall be located for convenient access and function if not specifically located on drawings, including all conduit and wiring required to be furnished and installed by this contractor. All thermostat and operable controls devices shall be located not higher than 48" AFF.

Furnish a complete control wiring diagram including written description and sequence of operation; train in operation and adjustment.

All control wiring shall be in accordance with electrical specifications.

The system shall be complete in all respects including all labor, materials, equipment and services necessary, and shall be installed by personnel regularly engaged in this type of work. The system shall include all appurtenances whether or not specifically implied or expressed herein or on the contract drawings.

All electrical signal wiring together with all field control wiring whether a part of the automation system or not shall be provided for all equipment in the mechanical section as a part of the work of this section.

Controls shall be installed, connected, checked out, and calibrated by this contractor, complete in all respects

Units shall be furnished with packaged control equipment. Wire in strict accordance with manufacturers recommendations, providing any and all wiring and conduit required to connect the various components together. System shall meet all N.C. Energy Code and ASHRAE 90-89 requirements.

Equipment to include all integral safety control devices as required. Supply and exhaust fans shall be “on” at all times when associated areas are in “occupied” mode.

Furnish a complete control wiring diagram from the manufacturer including written description and sequence of operation; train in operation and adjustment.

All control wiring shall be in accordance with electrical specifications and NEC.

The system shall be complete in all respects including all labor, materials, equipment, auxiliary relays, power transformers, and services necessary, and shall be installed by personnel regularly engaged in this type of work. The system shall include all appurtenances whether or not specifically implied or expressed herein or on the contract drawings.

All electrical signal wiring together with all field control wiring whether a part of the automation system or not shall be provided for all equipment in the mechanical section as a part of the work of this section.

AHU’s and split system units, shall be furnished with packaged control equipment as provided by the manufacturer; and field installed equipment / components, as required. Wire in strict accordance with manufacturer's recommendations, providing any and all wiring and conduit required to connect the various components together.

Installation, Submittals and Warranty:

Any control devices shall be located for convenient access and function if not specifically located on drawings, including all conduit and wiring required to be furnished and installed by this contractor. All thermostat and operable controls devices shall be located not higher than 48" AFF.

The system shall be complete in all respects including all labor, materials, equipment and services necessary, and shall be installed by personnel regularly engaged in this type of work. The system shall include all appurtenances whether or not specifically implied or expressed herein or on the contract drawings.

All electrical signal wiring together with all field control wiring whether a part of the automation system or not shall be provided for all equipment in the mechanical section as a part of the work of this section.

System offered as substitute to that used for design shall have suitable performance and final approval will be reserved pending satisfactory performance on the job. Replacement parts for all control components shall be kept in stock locally. Furnish a complete control wiring diagram including written description and sequence of operation.

The system shall be complete in all respects including: proper application, materials, equipment, auxiliary relays, power transformers, and services necessary, and shall be installed by personnel regularly engaged in this type of work. The system shall include all appurtenances whether or not specifically implied or expressed herein or on the contract drawings, and be installed complete in full accordance with manufacturer's recommendations.

All controls to be adjustable and exact setpoints determined and adjusted in building conditions in field.

The Mechanical Contractor shall include in his bid the services of the Controls system manufacturers factory trained field representative to check-out, start-up, calibrate, and adjust system. As part of the check-out and start-up service, field representative shall prepare a complete zone list of all devices and also a list of all settings. This information shall be included in contractor's operation and maintenance manuals. Field representative shall instruct Owner's representative completely in system operation. Field representative shall certify in letter form to the Engineer that all devices have been completely checked, calibrated and adjusted, and that all devices are functioning properly, and installed per manufacturer's installation instructions. Include in letter to Engineer name of Owner's personnel instructed in system operation.

The controls installer shall submit a complete wiring, logic, and schematic diagram for approval before installation. A written sequence of operation and flow diagram shall be included with control and wiring diagram showing all controls, functions, interlocks, wiring, etc., for approval; submittal shall be on sepia, if drawings are over 11" x 17" in size.

Upon completion of control installation, 1 sepia of control diagrams shall be sent to the Engineer, the control manufacturer shall thoroughly check and calibrate the control system and place it in working order as specified and to the Engineer's satisfaction. The contractor shall include in his contract complete instructions and necessary control data to the maintenance personnel on the installed control system. The control manufacturer shall then certify in letter form to the Engineer and Architect that all control requirements have been met and that all control components are calibrated and in working operation as specified and names of Owner's personnel instructed. All control settings shall be appropriately marked inconspicuously beside dampers, knobs, and adjustments, permanently. All relays to visually indicate energized/de-energized position or contain integral pilots. Post at each panel up-to-date, as installed, reduced control drawings; see previous section of specifications concerning instruction and parts manuals, warranties, service, etc.

Service and Warranty:

After installation, system start-up shall be performed. All controls and related components will be adjusted. The equipment being controlled by the system controls shall be in operation and fully inspected. The control system herein specified shall be free from defects in workmanship and material under normal use and service. If within 12 months from date of acceptance by owner/engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be repaired, adjusted or replaced free of charge by the installing contractor.

After completion and check of system, provide a minimum of (1) day training program for Owner's representative which shall stress operation of complete control system. During this period, log all temperatures, and temperature drops/rises across equipment hourly, stabilizing set down 5°, stabilize set up 10° stabilize, reset to original setpoint, stabilize and log.

15880 ADJUSTING, BALANCING, TESTING AND INSPECTION:

A. GENERAL

The testing and balancing of the heating, ventilating, and air conditioning systems shall be performed by an independent balancing agency approved by the Engineer. The test and balance shall be under the mechanical contract. The balancing agency shall have a minimum of five years' specialized experience in air and hydronic system balancing, and possess calibrated instruments, qualified test-and-balance engineers, and skilled technicians to perform all required tests. The balancing agency shall be either AABC or NEBB certified. The balancing agency shall provide proof of having balanced successfully at least five projects of similar scope and size.

The Mechanical Contractor shall keep a service technician on the job full time for the entire period that the test and balance technician is to coordinate work, assist in balancing and adjusting efforts, make corrections/changes indicated, and to communicate status and receive direction from the designer.

The personnel and procedures utilized shall comply with all standards as set forth by a national balancing organization, shall utilize AABC or NEBB procedural standards and forms, and ASHRAE Handbook chapter on Testing, Adjusting, and Balancing.

The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. The balancing agency shall then make available to the Engineer such instruments and technicians as are required for spot checks of the system.

The Engineer shall be notified in advance of all tests and inspections, so they may be able to witness such tests and inspections.

The balancing agency shall be submitted for approval within twenty (20) days of notice of award. Within 8 weeks of approval of the balancing agency by the Engineer, the balancing agency shall submit to the Engineer via the Mechanical Contractor three copies of a complete system test plan, to include copies of forms to be used, with equipment designations from plans, indicated; and instrumentation list with calibration dates included. This submittal shall also indicate that the balancing agency has reviewed the Contract Documents to ensure that all necessary dampers, balancing valves, and other devices required for correct balance and adjustment of the system are provided for and note any potential problem areas.

During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, HVAC equipment, and other component parts of the system. The inspection shall be performed periodically as the work progresses. A minimum of two inspections are required as follows: (1) when 60 percent of the ductwork is installed; (2) when 90 percent of the equipment is installed. The balancing agency shall submit a brief written report of each inspection to the Engineer via the Mechanical Contractor.

The balancing agency shall witness start-up and tests for all major HVAC equipment. Copies of test reports, including manufacturer's start-up check lists included in manufacturer's installation instructions, shall be included in the Test-and-Balance report.

System balancing and testing shall not begin until system has been completed and is in full working order. This contractor shall put all HVAC systems and equipment into full automatic operation and shall continue such operation throughout the testing and balancing period. Adequate time shall be allowed in the construction schedule for completion of all specified testing and balancing within the contract completion date, and prior to requesting final inspection.

During system balancing and testing, field data in rough form shall be forwarded daily to the Engineer. The balancing agency shall coordinate and review worksheets and findings daily with the Engineer as testing and balancing progresses to obtain direction for adjustments. The balancing agency shall notify the Engineer daily of any controls found inoperative, out of calibration, or otherwise needing adjustment. Any critical deviation of equipment capabilities or performance from design and specification requirements shall be immediately reported to the Engineer for his action, and noted in the Test-and-Balance report, together with recommendations for efficient and economical correction of the deficiency.

Once system balancing and testing is completed, provide a minimum of one day's training program for the Owner's designated personnel which shall stress operation of the complete control system. During this period, log all temperatures, and temperature drops/rises across equipment hourly. Allow system to stabilize; set down 5 degrees, stabilize; set up 10 degrees, stabilize; return to original setpoint, stabilize; and log at each setting. Transmit rough logs to Engineer within 24 hours of completion of this test, including names of Owner's personnel present.

The balancing agency shall cooperate with the controls sub-contractor, and shall certify the following in writing to the Engineer via the Mechanical Contractor prior to requesting final inspection:

(1) Certify that all system components are installed in accordance with the plans and specifications and are functional in accordance with the specified control sequence, including all electrical interlocks, damper sequences, air and water reset controls, fire and freeze stats, and all other safety and operating controls;

(2) Certify that all control instruments are calibrated and set for design operating conditions; and

(3) Verify the accuracy of the final settings and operation of control sequence in automatic operation by recording space temperature in a typical conditioned space for each separately controlled zone for a minimum of 48 hours of system automatic operation, and transmit chart recordings to the Engineer within 24 hours of completion.

Energy Balance and Performance Test: Measure the inlet and outlet temperatures and flow rates of each fluid on each chiller, boiler, and air handler coil, and determine the BTU input and output. Measure volts and amps and determine KW input as applicable.

Prior to Owner's occupancy of the project, train the Owner's authorized personnel on how to operate, start-up, shut-down, and service the various parts of the system, and furnish Engineer a letter stating this has been done to Owner's satisfaction and listing names of Owner's personnel so instructed.

The settings of dampers, splitters, valves, pulleys and other volume adjusting devices and flow meter readings shall be permanently marked after completion of balancing and adjusting, so that they can be restored if disturbed at any time. The balancing agency shall verify that all switches, starters, control devices, relays, night and day thermostats, overcall switches, and other equipment are identified as specified with approved nameplates, and all setpoints marked. The balancing agency shall verify that the locations of all dampers, valves, etc., located above lay-in ceilings are accurately marked by color-coded marker dots on the ceiling grid as specified.

The Controls sub-contractor shall include a warranty of one year, after acceptance of system, during which time the Engineer at his discretion may request a re-check, program revisions, re-setting of any loops sequence, fine tuning, optimizing, etc., or reconfiguration. The controls sub-contractor shall provide technicians and equipment necessary to assist the Engineer in making any tests, or adjustments he may require during this period of time without additional cost.

The balancing agency shall include a warranty of one year, after acceptance of test and balance work, during which time the Engineer at his discretion may request a re-check, or re-setting of any outlet, fan, pump, etc., as listed in the Test-and-Balance report. The balancing agency shall provide technicians and equipment necessary to assist the Engineer in making any tests or adjustments he may require during this period of time.

The balancing agency shall perform a follow-up inspection of the HVAC system during the opposite season from that in which the initial adjustments were made, make any necessary modifications to the initial adjustments to produce optimum system operation and maintain comfort conditions. The peak design cooling and peak design heating conditions must be determined on these days for the seasons not reported in the start-up. Submit a report of this inspection, including problems noted and adjustments made, to the Engineer. The balancing agency shall notify the Engineer in advance of this inspection.

AIR SYSTEM PROCEDURES

Test and adjust fan speeds to achieve design CFM and SP requirements in all modes of operation. If a fan pulley cannot be adjusted to suit the CFM and SP required, it shall be changed. Lubricate all motor and pulley bearings. Check all belts for proper tension and alignment. Check all motors and equipment for proper rotation.

Measure and record motor speed, current, and voltage, nameplate data, sheave sizes and belt sizes in all modes of operation.

Perform a Pitot-tube traverse of main supply and return ducts to obtain total CFM in each mode of operation (e.g., heating, cooling, economizer, etc.). If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used after consultation with the Engineer. Explanation why traverse was not used is to be included on the appropriate data sheet.

Test and adjust system minimum outside air by Pitot-tube traverse in each mode of operation. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.

Test and record system static pressures, including suction and discharge static pressure of each fan.

Take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

Test and balance each diffuser, grille, and register to within 10 percent of design requirements. All adjustments are to be made at terminal boxes, trunk ducts or run-out ducts, not at volume control dampers in outlet devices. Adjust all diffusers, grilles, and registers to minimize drafts in all areas.

Adjust heat recovery and exhaust systems and relief dampers to exhaust air quantities specified. Record fan nameplate data, and actual RPM, CFM, SP, and amps at each speed of operation. Verify operation of motor- or gravity-operated backdraft dampers.

TEST AND BALANCE REPORT

The test-and-balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed and bound. The report shall be certified accurate and complete by the balancing agency's certified test-and-balance engineer. Submit three copies of the certified test-and-balance report to the Engineer. The report shall be evidence that the system has been tested, adjusted, and balanced in accordance with AABC, NEBB, or ASHRAE standards; are an accurate representation of system performance at the completion of testing and balancing; and are an accurate record of all final quantities measured, to establish normal operating values of the systems.

As part of the report, submit one copy of the contract drawings marked "as-built" to the Engineer. Indicate actual CFM at each grill, static pressures, inlet and outlet water and air temperatures, pressures, GPM at each, and test point codes. Record the following items at each cooling and heating element: inlet and leaving water and air temperatures, pressure drop of each coil or bypass valve, water and air metering device readings. For each pump record operating and discharge air pressures and final TDH. Record identification of all measured points to cross-reference with tabulated data. Verify as-installed locations of all dampers, balancing valves, and other control devices are accurately shown.

The test-and-balance report shall be recorded on report forms conforming to recommended forms in AABC or NEBB standards and as approved by the Engineer in the test plan. As a minimum the report shall include:

Preface - a general description of the system, equipment, and controls, and discussion of any abnormalities and problems encountered.

Instrumentation list - The list of instruments including type, model, manufacturer, serial number, and calibration dates.

System identification - Supply, return, and exhaust openings, zones, traverse points, terminal equipment such as VAV boxes, fans, air handling units, heating/cooling coils, and other equipment shall be identified to correspond to the identification used on the report data sheets. Such identification shall also correspond to the identification on the project drawings, field labels, and owner designations.

Air handling equipment test report forms - Record the following for all air handling equipment in each mode of operation: manufacturer, model number, serial number; all design and manufacturer-rated data; total actual CFM by traverse or other approved method, CFM grill totals; suction and discharge static pressure of each fan; outside air and return air total CFM; actual operating current, voltage, and brake horsepower; motor and fan final RPM; fan and motor sheave manufacturer, model, size, number of grooves, and center distance; belt size and quantity; static-pressure controls final operating set points.

Heating and cooling coil test forms - Record the following items for each heating or cooling coil: manufacturer; all design and manufacturer's rated data; rated and actual water pressure drop through each coil and related GPM; rated and actual static pressure drop across each coil; entering and leaving water temperatures; wet-bulb and dry-bulb temperatures of air entering and leaving each cooling coil; dry-bulb temperatures of air entering and leaving each heating coil.

ELECTRICAL

DIVISION 16000

16001 GENERAL:

A. GENERAL CONDITIONS:

This Contractor's attention is directed to the requirements of Instructions to Bidders, General Conditions and Supplementary General Conditions as bound in the specifications which apply in full to the electrical contract.

B. SCOPE:

Provide all labor, materials, tools, equipment, and transportation, and perform all operations necessary for and reasonably incidental to proper execution and completion of all "Electrical" work, whether specifically mentioned or not, all as indicated, specified herein, and/or implied thereby to carry out the apparent intent thereof. These drawings may be superseded by later revised or detailed drawings, specifications, or sketches prepared by the Designer, as needed for clarification, and this Contractor shall conform to all reasonable coordination requests. All items not specifically

mentioned in the specifications or noted on the drawings, but which obviously are required to make the working installation complete, shall be included automatically.

Electrical Contractor shall furnish and install conduit and power wire, systems for lighting and power, and shall furnish and install raceways for telephone, special systems, fire alarm, special equipment, etc., as called for and described on the electrical drawings or herein, complete and ready to operate in every respect, including connection of equipment furnished by Owner.

C. CODE AND ORDINANCES:

All work performed shall be in accordance with the latest requirements of the 2014 edition of National Electrical Code, North Carolina State Building Code, and all state and local codes, ordinances, rules and regulations, when more stringent requirements are imposed by governing regulations, they must be complied with.

If Contractor notes discrepancies between laws, codes, ordinances, rules and regulations, and the specifications or drawings, each discrepancy shall be called to the attention of the Designer in writing before the bids are submitted. That work which is shown or specified in violation of these rules and regulations shall be done in compliance with the regulations, and no claim for additional cost required to make implied systems complete will be accepted.

D. PERMITS AND FEES:

This Contractor shall secure all permits required for the completion of this contract. He shall obtain and deliver to the Owner all certificates of inspection issued by the authorities having jurisdiction, with Contractor paying cost of same.

E. VISIT TO JOB SITE:

Before submitting a bid, this Contractor shall visit the job site for the propose of thoroughly examining the site and conditions under which the work must be performed. The submission of a bona fide bid will be construed to mean that this Contractor understands and is satisfied with conditions under which the contract must be fulfilled. No extra compensation will be allowed for situations arising from conditions, including charges and requirements for connection to utilities as shown for this project.

F. WORKMANSHIP:

Workmanship in the fabrication, preparation, and installation of materials and equipment shall conform to the best standards of practice of the trades involved. Work shall be performed by

experienced and skilled mechanics under the supervision of a competent foreman. Substandard workmanship will be cause for rejection of work and replacement by this Contractor. All costs associated with providing engineering assistance due to substandard work by the contractor shall be assumed by the contractor including time expended, telephone, and travel.

G. DRAWINGS AND SPECIFICATIONS:

The drawings show the location and arrangement of fixtures, conduits, ducts, and equipment, together with details of connections of certain principal items. The layout shown shall be followed as closely as circumstances will permit, but this Contractor shall lay out his work so as to avoid conflict with other Contractors and trades, and to avoid any unnecessary cutting or damage to walls, floors, and supporting structural members. He shall, therefore, carefully and accurately locate and install at the proper time all necessary sleeves, hangers, inserts, etc. which will be required for the completion of his work, and shall be solely responsible for the accurate and proper location of above items.

This Contractor shall refer to architectural, mechanical, and plumbing drawings and shall cooperate fully with other Contractors and trades while installing conduit, fixtures, and other equipment because of close space limits. In case of conflict, notify Designer before proceeding with installation. Refer to architectural drawings for exact building dimensions and location of partition wall, doors, chases, etc. Electrical drawings are not to be scaled for such dimensions.

The drawings and specifications complement each other and together are intended to give a complete description of the work. Any item of equipment or note of work to be done as shown on plans and not mentioned in the specifications, or mentioned in specifications and not shown on plans, shall be furnished the same as if mentioned or shown in both places. If conflicts exist, then the most stringent method shown or described should apply.

Any switches, controls, or equipment included in this contract work (drawings and/or specifications) that is not specifically shown on drawings shall be located for convenient use and access. Contractor to coordinate all equipment arrangement and lay-out in field prior to beginning any actual installation of his work.

If Contractor notes any discrepancy, omission, or conflict found in plans or specifications, he shall call to the immediate attention of the Designer, prior to receipt of bids.

It is the intention that piping, air ducts and light fixtures are designed and laid out to clear each other. It shall be the responsibility of this Contractor to coordinate his work with that of other trades to avoid any such conflicts. Any conflicts that occur after work of one trade is installed and was not prior coordinated shall be relocated or rearranged at the total expense of this Contractor, as directed by Designer. Any conflicts that cannot be corrected in field by relocation or elevation changes shall

be reported to Designer in writing prior to any installation.

The drawings are not intended to show each and every complete or accurate detail. The figures and writing on drawings shall be taken instead of scaling. It is this Contractor's responsibility to comply with the evident intent for centering and symmetric arrangement. This Contractor shall take all field measurements and be responsible therefore. Exact locations and relations are to be defined in the field and shall be satisfactory to the Designer.

Because of the small scale of electrical drawings it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, and accessories required to meet the conditions.

H. CUTTING AND PATCHING:

This Contractor before installing any of his work shall see that it does not interfere with clearances required for finished walls, partitions, equipment, etc., as shown on mechanical, plumbing, and architectural drawings and details. If any work is so installed and it later develops that the architectural design cannot be followed, this Contractor shall, at his own expense, make changes in his work as directed by the Designer so that the architectural design may be followed.

Any cutting or patching required by the failure of this Contractor to place sleeves and install inserts, hangers, etc., at the proper time, or failure to accurately locate above items, shall be done at Electrical Contractor's expense. This Contractor shall advise General Contractor at proper time an exact location of all roof, wall and floor opening. All such penetrations shall have sleeves.

Any cutting of walls or structures required for the installation of work under this division shall be done by this Contractor. Holes through walls for passage of conduits, etc., shall be properly and neatly sleeved and grouted. All sleeve openings to be appropriately sealed at completion of construction. Sleeves through exterior walls shall be effectively sealed against passage of water.

This Contractor shall properly firestop all floor and wall penetrations utilizing rated assemblies to provide the required fire protection. Firestopping is to be installed in strict compliance with the U.L. through-penetration firestop system(s) applicable or as shown on the plans, or an approved equal. Submit shop drawings showing manufacturer's installation details/sections for approval. Persons installing firestopping shall have on site the approved firestopping submittals during installation, and at final inspection. Firestopping shall be installed per manufacturer's installation instructions and in strict compliance with U.L. rating.

All disturbed areas shall be refinished and left in a finished and matching condition and must meet approval of Designer.

I. TESTS:

The right is reserved to conduct acceptance tests of all equipment, wiring, or any other work furnished under these specifications to determine the fulfillment of special requirements. Such tests shall be conducted in the presence of authorized representatives of this Contractor, Owner, Engineer, and Architect at such time as the Designer may designate. This contractor shall perform all tests, bear cost of same and make adjustments of equipment and wiring as may be deemed necessary by the Designer.

J. ALLOWANCE FOR ADDED WORK:

Before proceeding with any work for which compensation may be claimed or the Owner may claim credit, a detailed estimate shall first be submitted and approved in writing. No claim for addition to the contract sum will be valid unless so ordered and approved by the Owner and Designer, prior to start of work. Any conflicts corrected by relocation or elevation changes do not constitute extra work.

K. AS INSTALLED PRINTS:

This Contractor shall maintain a set of prints, showing exact locations of all relocated equipment, concealed equipment, service accesses, hand holes, underground lines, and all other changes to plans. This set shall be kept current and turned over to the Designer upon completion of the job. Show dimensions to locate all underground conduit and lines from permanent reference points.

L. STANDARDS:

All work performed and all equipment furnished by this Contractor shall be in accordance with applicable standards as published by ANSI, NFPA, and U.L.

M. INCIDENTAL CONSTRUCTION WORK:

All blocking for openings, ducts and pipes in concrete floors, masonry walls, or partitions shall be provided by this Contractor. This Contractor shall do all cutting and fitting of his work and of other work that may be required to make the several parts come together properly and to fit his work to receive or be received by the work of other Contractors as shown upon, or reasonably implied by the drawings and specifications. He shall properly complete and finish up his work after other Contractors have finished as the Designer may direct.

All excavating required for the installation of this system shall be done by this Contractor and shall be unclassified; and backfill shall be accomplished as specified in appropriate section of

specifications.

Chases are prohibited in masonry walls which are not to be plastered or paneled. Set conduit and boxes indicated to be concealed in unplastered or unpaneled masonry walls before walls are constructed in order that walls may be constructed around pipes or ducts. This Contractor shall furnish all sleeves in floors, beams, walls, etc., for each such penetration as needed for installing his work, and installation of sleeves by General Contractor.

Unless otherwise noted, the General Contractor will provide openings and lintels as new construction progresses, but this Contractor shall fully designate his requirements prior to construction. Failure to furnish his requirements prior to building construction and failure to coordinate his work with the building construction shall make this Contractor responsible for removing, replacing and painting building construction as required for installation of his work.

N. CLEANING AND PAINTING:

This Contractor shall at all times keep the Owner's premises, adjoining driveways and streets clean of rubbish caused by this Contractor's operations and at the completion of the work shall remove all the rubbish from and about the premises, all his tools, equipment, temporary work, surplus material and shall leave the work clean and ready for use.

This Contractor shall be required to perform touch-up painting on factory finished equipment installed under this contract where necessary to repair abraded or scarred areas and make a clean and neat installation at the direction of the Designer. All metal exposed to weather shall be properly painted. Any equipment installed exposed to weather shall have all abraded areas cleaned, primed, and be painted one complete coat by this Contractor.

After facility is ready for operation, clean all dirt from all machinery, equipment, fixtures, controls, etc.

O. SUPERVISION

This Contractor shall have in charge of the work at all times during construction a thoroughly competent foreman with extensive experience in the work to be performed under this contract. Anyone deemed not capable by the Designer shall be replaced immediately upon request, and after satisfactory foreman has been assigned, he shall not be withdrawn without the written consent of the Designer.

P. GUARANTEE:

This Contractor shall guarantee all materials, equipment, workmanship and each and every piece of apparatus which he furnished and which he installs under this contract against defects and failures of any nature for a period of one year from date on which the system is accepted. Apparatus furnished by this Contractor shall be guaranteed to be satisfactory when operated under rated conditions in accordance with manufacturer's instructions and to be of size, function, and capacity specified on drawings or in the specifications. Equipment manufacturers shall warrant equipment furnished for this project for same time span as installing contractors warranty period as set above and elsewhere in these specifications. Upon notice from the Designer or Owner, he shall immediately check system, make necessary repairs or adjustments as required; due to faulty workmanship, materials, faults, operation or equipment, without cost to the Owner, and instruct Owner in proper operation, adjustment, and care of systems.

Q. INTERFERENCES:

This Contractor shall cooperate with all Contractors on the building and shall confer with all Contractors installing mechanical work and equipment which may effect or come in contact with this work. He shall make necessary visits to site and examination of other trades to verify dimensions, installation conditions and conflicts, storage facilities, etc.; he shall examine approved shop drawings and arrange his work in proper relationship to other work and apparatus and with the architectural finish in an approved manner.

It is the intent that piping, air ducts and light fixtures are laid out to clear each other; it shall be the responsibility of this Contractor to coordinate his work with that of other trades to avoid any such conflicts. Any conflicts that occur after work of one trade is installed and was not prior coordinated, shall be relocated or rearranged at total expense of this Contractor, as directed by Designer. The conflicts that cannot be corrected in field by relocation or elevation changes shall be reported to Designer in writing prior to any installation.

R. IDENTIFICATION:

All equipment shall be identified and properly marked. All marking must meet Designer's approval. All markers shall be of appropriate size. Minimum letter height 3/16". Each switchgear unit, transformer, panel, contactor, starter, and other piece of electrical equipment shall be identified as to their service. All nameplates shall be engraved laminated phenolic attached with screws.

All disconnect switches, junction boxes, motor controllers, and other equipment requiring electrical power connection shall be marked with voltage present, as appropriate to designate 120,208, volts and single or three phase, as applicable.

Where equipment requiring adjustment, servicing or checking is located above lay-in ceiling panels.

Each ceiling panel is to be identified with a coded marker signifying that it provides access to that particular equipment such as control devices, smoke detectors, junction boxes, etc.

S. MAINTENANCE AND OPERATION INSTRUCTIONS:

Operating and Maintenance Instructions on all equipment shall be provided:

Owner's manuals: Organize owner's operation, maintenance, and installation instructions into sets of manageable size. Bind in individual heavy-duty 3-ring vinyl-covered binders of appropriate size, with pocket folders for folded sheet information. Mark identification on front and spine of each binder. Submit four (4) complete copies to the Engineer for review prior to final inspection. Include the following information, with tabs to separate information for each piece of equipment:

Submittal data

Spare parts lists

Manufacturer's operating, installation, and maintenance instructions

Copies of warranties

Wiring diagrams

Report of contractor’s check-out.

Names and addresses of manufacturer's or subcontractors and suppliers.

Provide rack in main equipment room for owner's manual storage. Provide a plastic envelope on the wall of each equipment room with inspection certificates, control diagrams, elementary wiring diagrams, piping schematics, valve lists, etc.

Prior to Application for Final Payment of the contract, this Contractor shall be responsible to train owner's personnel.

Owner training: Train owner's personnel in system and equipment operation and maintenance, including normal and emergency operation, start-up and shut-down, troubleshooting procedures, repair procedures, routine preventive maintenance procedures and frequencies, normal adjustments, safety precaution, warranty terms and procedures, and assistance available from manufacturer's authorized service representatives. Training is to include review of owner's manual information described above. Where required elsewhere in these specifications, training is to be conducted by manufacturer's authorized service representative or factory representative as part of equipment start-up specified. Upon completion of training, the organization conducting training shall submit on its letterhead to the Engineer a letter stating what training was conducted, date of training, names of owner's personnel trained, and name of person conducting training.

The Electrical Contractor will be furnished with manufacturer's shop drawings of equipment to be furnished by others or by the Owner, that are to be connected by him.

Upon acceptance of this letter, and final inspection and approval of this project, the one year warranty period on all equipment and systems installed by this Contractor shall start, from that date.

T. ELECTRICAL WORK BY OTHERS:

Refer to the drawings for the details of locations of circuit breakers, junction boxes, conduits and slack wire required where this Contractor's electrical work terminates and electrical work by others begins.

The Electrical Contractor shall furnish and install all power circuits for equipment furnished by others.

In Mechanical Rooms the wiring by the Electrical Contractor generally shall terminate in a power wiring gutter, disconnect switch, junction box, or electrical panel. From these points power wiring to the equipment furnished by the Mechanical Contractor generally shall be by the Mechanical Contractor.

Power wiring to mechanical equipment outside equipment rooms will generally be run by the Electrical Contractor to a junction box in the vicinity (within 3' of) of the mechanical equipment. Power wiring from that point to the equipment will be generally by the Mechanical Contractor.

Electrical Contractor is to refer to the drawings for location and type of service connections to be provided under the electrical contract.

Where service disconnect switches are required and not furnished as part of the equipment, they shall be furnished and installed by Contractor that furnishes the equipment.

Other Contractor shall furnish and install conduit, boxes, wiring and all items of control for equipment they furnish or Owner furnished equipment.

The Electrical Contractor shall furnish and install all electrical starters, disconnect switches, controls, wiring, and safety devices required for the proper installation and operation of equipment installed under the Electrical contract.

Disconnect switches, controls, and power connections shall be located for convenient access if not specifically located on the drawings.

The Electrical Contractor is to connect and test all other equipment and shall provide powered receptacles, cords and mating caps for equipment that is cord connected.

U. SHOP DRAWINGS:

Upon award of the contract, this Contractor shall submit to the Designer within ten (1O) days, for approval, a list of all proposed subcontractors and materials he proposes (within the three listed manufacturers as equivalent) to utilize for approval by Designer, Contractor to include a submittal schedule/status log listing all items of submittal and shop drawings on AIA Form G712 or similar form, and within four (4) weeks of approval, supply eight (8) sets of shop drawings consisting of detailed drawings or manufacturer's cuts of all manufactured equipment he proposes to use on the job. The drawings or cuts shall show details of construction and arrangement of all pertinent data pertaining to equipment proposed to be furnished. The approval of the Designer shall be obtained before equipment is ordered for delivery.

The purpose of submittals is for the Contractor to demonstrate how the material and equipment this Contractor proposes to provide and install comply with the requirements of the Contract Documents. By submitting Shop Drawings, Product Data, Samples and similar submittals, this Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria and details related thereto, or will

do so, and has checked and co-ordinated the information contained within such submittals with the requirements of the Work, the Contract Documents and the Work of other trades.

Approval of the Designer shall be for general fitness and design only. It will be the duty of this Contractor to verify quantities, dimensions, and details, and determine suitability of equipment for installation in space provided. Approval of shop drawings by the Designer does not relieve this Contractor of the responsibility for coordination, dimensions, quantities or details.

If submittal shows variations from the contract requirements, the Contractor shall note on submittal and shall describe all differences (i.e., increased amperage, horsepower, physical size, capacity, flow, etc.) in writing (on letter of transmittal) separate from notations on submittal shop drawings.

This Contractor shall check and approve shop drawings making such notations and corrections as may be appropriate or necessary to comply with specifications before submission to the Designer. Submittals with variations and/or substitutions as equivalent by the listed manufacturers as specified or by those approved as equivalent 10 days prior to bid (see Materials Section) shall also contain a statement that this Contractor has coordinated same with other Contractors and Designers affected and list any changes required, refer to Materials Section.

Shop drawings and/or submittal data shall be submitted on items listed as follows:

Wiring Devices

Electrical Distribution Equipment

Fire Alarm Systems

Conduit & Wire

Firestopping for all Penetrations Applicable

V. TEMPORARY UTILITIES:

All necessary utilities such as water and electricity shall be furnished by General Contractor during construction.

This Contractor shall provide and maintain for duration of job all temporary construction power distribution panels 120/240 Volt 1 Phase and sufficient outlets throughout project spaced no greater than 100 feet apart, and wired per 2014 edition of National Electrical Code, and required temporary lighting for construction.

Temporary lights shall be equipped with guards and not suspended by their cords, unless so approved. Permanent light equipment may be used for this purpose but must be thoroughly cleaned

at completion of job by this Contractor, and new lamps installed.

Walkways shall be kept clear of cords. Extension cords shall be grounding type and without splice.

All switches and disconnects shall be plainly marked.

Temporary lighting to maintain minimum level of five (5) foot candles in all general construction areas, and three (3) foot candles in all excavation and concrete placement areas, at all times that work is in progress and when natural illumination provides lower lighting levels than above specified.

Temporary lighting to be provided by use of Daniel Woodhead #300 fixtures, Whitney-Black 732-1290, Duraline fixtures and guards, or equal, with guards and maintained with 200 watt lamps, and located in areas to provide illumination specified above.

General Contractor to pay for power consumed and Utility Company Up-Down charges.

W. EXISTING FACILITIES:

Every precaution shall be taken to prevent damage to existing underground lines and structures and public utilities. Damage to existing water and sewer lines, culverts, service connections, underground cables, and similar surface and sub-surface structures shall be at the expense of this Contractor, which shall be completed without delay.

The locations of any existing underground utilities that are shown are in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work, and agrees to be fully responsible for any and all damages which might be occasioned by the Contractor=s failure to exactly locate and preserve any and all underground utilities.

X. ADAPTATION OF WORK TO EXISTING CONDITIONS:

It is reasonably implied that this Contractor is to furnish all labor and materials to provide Owner with a new and satisfactory system in these facilities. This Contractor is to include necessary work for adaptation of equipment to conditions that may be found to produce conflicts during construction. When any such conditions are encountered, this Contractor is to consult with Designer and then modify installation as directed without additional costs, and to include any incidental materials required.

Y. STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT:

The Electrical Contractor shall be responsible for furnishing suitable shelter and protection for all materials and equipment stored on the job.

Equipment shall be protected from damage from any source both during storage and after installation until completion of the job. No damaged equipment will be accepted.

Z. CLEAN UP:

The Electrical Contractor shall be responsible for keeping work areas clean and free of trash and debris resulting from his operations.

When work is conducted in occupied areas, clean up shall be accomplished daily and work areas left clean at end of day's work.

When all equipment and systems have been set and ready for use, they shall be thoroughly cleaned, removing all labels, plaster, rust and stains, and left in perfect working order.

AA. DELIVERY AND HANDLING OF EQUIPMENT FURNISHED BY OTHERS:

All electrical equipment furnished by the Owner and others which is to be installed and connected by the Electrical Contractor as hereinafter specified will be delivered and turned over to this Contractor. Storing and protection of such equipment and furnishing of all applicable accessories and miscellaneous fittings to make complete shall be done by the Electrical Contractor.

BB. RESTORATION OF PROPERTY:

This Contractor shall carefully restore all property defaced by operations or acts of any of his agents or employees. Such restoration shall include seeding, sodding, and transplanting of lawns, hedges, ornamental planting, and the repair or replacement of driveways, walks, fences, steps, or other facilities in such a manner as to meet with the approval of the Designer and to be least equal in quality to the original undisturbed work.

CC. PROJECT CLOSEOUT

When this Contractor considers that his work is complete in all respects, per plans and specifications, he shall conduct an inspection of project with office and field supervision personnel and prepare a punchlist of outstanding/incomplete/deficient items of work. This inspection shall include review of all specified documentation, certificates, warranties, and close-out information.

When this Contractor considers the above punchlist to be completed or corrected he shall submit to the Designer, in writing, a request for Final Inspection. The request for Final Inspection shall have as attachments the following items:

-- Punchlist prepared by the Contractor, indicating by check-off all completed items (each item individually checked on the list, not a cover letter stating that all items on attached list are complete);

-- One copy of the Contractor's Maintenance and Operation manuals for review by the Designer;

-- As-built marked prints;

-- Copy of the Certificate of Occupancy issued by the local authority having jurisdiction;

-- Contractor's certificate that he has completed all work, per plans and specifications, that he has installed all items in accordance with manufacturer's installation instructions and all applicable codes, and that all systems/equipment furnished have been tested and are in full working order; (see enclosed Certificate Form);

-- Contractor's certificate that the as-built marked prints he provided are complete and accurate in all respects, and that any deviations from original design plans and/or specifications are clearly and accurately shown thereon, including all change orders;

-- Certification of fire alarm systems per NFPA 72;

-- Letter(s) documenting Owner training in operation and maintenance of systems and equipment.

This Contractor is advised to allow adequate time in the project schedule to complete all work, including all specified testing, check-out, inspections, certifications, etc., prior to the contract completion date listed in the Notice to Proceed or other such notification, and before it is necessary for the Owner to occupy the facility.

Once the Final Inspection has been conducted, the Designer will issue to this Contractor a punch list of outstanding/deficient items. The Contractor will pursue corrective action to complete the Final Inspection punch list in an expeditious manner. Once all items on the Final Inspection punch list are complete, the Contractor is to submit to the Designer a copy of the Final Inspection punch list with all items checked off, attaching any outstanding documentation required. Additional visits by the Designer which may be required because above procedure has not been followed or accomplished; or, which are necessary to check off Final Inspection punch list items will be at the expense of the Contractor.

Refer to the General Conditions for the completion requirements. As a minimum, the following items must be fully complete, and proper documentation submitted to the Designer, before the Owner can be allowed to occupy any portion of the facility:

-- All life safety systems must be fully operational and certified, including fire alarm, emergency power, egress lighting, etc.

-- Approval of the local authority having jurisdiction through issuance of a Certificate of Occupancy.

-- Owner trained in operation and maintenance of systems and equipment.

CONTRACTOR'S CERTIFICATE OF COMPLETION

PROJECT:_____

CONTRACTOR:_____

I hereby certify the following:

a. That the work on the above-referenced project has been completed in accordance with the plans and specifications, and that all equipment and materials provided have been installed in accordance with manufacturer's installation instructions and all applicable codes;

b. That all items on specified contractor's inspection punch list (copy attached) are completed; and all items on designer's punchlist(s) are completed;

c. That all tests and inspections and sub-contractor's certificates and reports specified in the contract documents have been properly conducted and documented as specified, and that all equipment and systems are now completed and in proper working order;

d. That the as-built marked prints submitted to the Designer are complete and accurate in all respects, showing all deviations from original design plans and all other items specified;

e. That the following Owner's personnel were trained in operation and maintenance of equipment and systems installed under this contract (list names of Owner's personnel and date(s) training was conducted), as specified:

_____

_____

_____

(Contractor)

_____

(Title)

_____

(Date)

16100 ELECTRICAL MATERIALS AND METHODS:

Materials and workmanship on all work installed under this contract shall be new and of the best quality and shall conform to the best practice for such work and be installed in accordance with manufacturer's recommendations and instructions, including all hardware and accessories recommended or appropriate. Any work or materials not specifically mentioned in these plans and specifications, but required to make this job a complete and workable system shall be furnished and installed by this Contractor. All materials, fixtures, apparatus and materials and methods of installation shall meet with approval of the Designer.

BASIS OF DESIGN: Certain items of manufactured materials and equipment are cited by manufacturer's or product name and model number. This is to establish a standard of design and quality, and is not intended to be restrictive as to the use of materials and equipment of similar design and equivalent quality by other manufacturers, which may be used subject to the approval of the Designer.

A. Proposed Equivalent Products: Items proposed as equivalent to those cited will be considered by the Designer **up to 10 days prior to receipt of bid,** and shall be subject to the approval of the Designer.

After that date, no equivalent material or substitution will be considered or approved, and all

items shall be as specified.

Approvals to consider a proposed brand as being equivalent are for acceptable quality range and are not intended or to be construed as a detailed review of products, features, accessories, mounting hardware, compatibility with other equipment being furnished and space available. Preceding are the Contractors responsibility to insure a complete and coordinated installation of this product and must be submitted for approval and review as specified for submittal data. The approval to bid a proposed equivalent brand as a acceptable equipment design product does not relieve the contractor of this responsibility.

Equivalent Products proposed for approval for equipment specified must be equal in every respect and this Contractor shall base his proposal on the quality of materials and equipment covered in these specifications and shown on the drawings, complete with all accessories, hardware, features and functions to provide the same satisfactory performance on this project as the specified item or system. If substituted equipment fails to perform satisfactorily, it shall be replaced with the specified equipment as directed by Designer. If required by the Designer, this Contractor shall submit for inspection samples of both the specified and the proposed substitute items for comparison by the Designer and test data from a recognized independent testing laboratory for both pieces of equipment.

Where equivalent products proposed and approved for bidding alter the design or space requirements indicated on the plans, this Contractor shall include all items of cost for the revised design and construction, including the cost of any changes or modifications in structural or architectural details, and/or electric service, and the cost of all allied trades involved resulting from use of equivalent product or equipment. This Contractor is to coordinate and bear all cost where such differences affect other Contractor's work.

B. Material Deliveries: This Contractor shall provide to the Designer as soon as possible, and not later than seven (7) weeks after job is awarded, copies of factory acknowledgements of orders of all major items of material, i.e. panelboards, light fixtures, controls, special systems, etc. These acknowledgements should show date of factory entry and delivery dates promised by the supplier and be updated as job progresses or changes occur. Subsequent monthly applications for payment will not be processed for payment until above information is received each month.

C. TESTING AGENCY APPROVAL OR LISTING:

1) All fabricated assemblies of electrically operated equipment furnished under this contract shall have approval and listing of recognized third party agencies currently accredited by the NCBCC to label electrical and mechanical equipment , or other agency satisfactory to authority having jurisdiction; in every case where such

approval and listing has been established for said assemblies or equipment.

2) All manufactured items of electrically operated equipment shall have approval and listing of recognized third party agencies currently accredited by the NCBCC to label electrical and mechanical equipment , or other agency satisfactory to authority having jurisdiction; in every case where such approval and listing has been established for said items of equipment.

16110 CONDUITS AND RACEWAYS:

All wiring will be in conduit or other approved raceways except as shown on the drawing or otherwise specified, and will be concealed unless otherwise noted.

Conduit sizing on plans based on type THHN/XHHW conductor insulation.

Conduit will either be rigid galvanized steel, rigid P.V.C., galvanized electrical metallic tubing, steel flexible, or intermediate grade steel as applicable.

Minimum size conduit for Telephone, Data, CATV, and Fire Alarm shall be 3/4".

In general, all interior raceways above grade will be electrical metallic tubing, and all raceways under slabs inside building will be rigid P.V.C. or steel. Conduits will not be run in slab without permission of Structural Engineer.

P.V.C. may not be used in "Areas of Assembly", except where run under slab and turned up into boxes concealed in masonry wall.

Rigid steel conduit will be utilized where conduit is exposed and subject to damage.

E.M.T. will be utilized for all interior work; and for all interior telephone raceways, unless installed below slab where PVC may be used.

Rigid P.V.C. Conduit will be utilized for exterior work below grade, and shall always have Allen or Brady marker tape placed above, 6" below finished grade.

Rigid steel or PVC conduit shall be installed where routed in poured concrete, in exterior masonry walls, or in wet locations.

Conduits shall not be installed in slabs without the written permission of Architect and/or Structural Engineer.

Minimum depth for exterior buried raceway is 3' below finished grade.

Flexible conduit shall be used for motor, transformer and lay-in fixture connections. Length shall be limited to 24" for motors and 6 feet for fixtures. Where exposed to moisture, P.V.C. coated "Sealtight" shall be utilized. Provide insulated green bond wire.

Fittings for E.M.T. shall be as follows:

Plated hexagonal steel compression type, or steel set screw type **insulated throat**.

No pot metal or die cast types permitted.

No "indentor" type devices permitted.

Where P.V.C. raceway is utilized in lieu of metallic raceway, a copper bonding conductor shall be provided, sized per N.E.C.

Conduit may be run exposed only in mechanical room and where specifically noted on drawings and

may be deemed necessary and approved by the Designer, and it shall follow exactly the location as shown. All exposed conduit runs shall be so located that pull or junction boxes will not be made inaccessible due to inadequate clearance with piping or equipment immediately below or adjacent to be installed under this contract.

All conduits used for service entrance feeders from supply point to first overcurrent device shall be bonded with suitable bonding locknuts and/or bonding insulating bushings as manufactured by T & B. O.Z., or Appleton, or by separate copper bonding conductor.

In finished areas where conduit cannot be concealed, surface raceway such as Walker or Wiremold and fittings shall be used, with specific installation and routing approved by Designer. Manufactured appropriate fittings shall be utilized as applicable.

16115 SURFACE RACEWAYS/ WIREWAYS:

A. GENERAL:

Scope

The raceway system shall consist of raceway, appropriate fittings and device boxes to complete installation.

Raceway system shall include, but not be limited to, all hardware, mounting devices, adapters, clips, inside and outside corners, offset sections, connectors, end caps, covers and nipples.

Conductors shall be carefully installed in raceway and boxes to prevent nicking conductors' insulation.

Surface raceway is to be utilized in dry interior locations only as covered in Article 352 Part A of the National Electrical Code, as adopted by the National Fire Protection Association and as approved by the American National Standards Institute. The Raceway System shall be listed by Underwriters' Laboratories.

B. PRODUCT:

Manufacturer

The surface raceway system specified herein shall be as manufactured by The Walker/Wiremold Company, Panduit, T& B, Carlon, Hoffman or other approved equal. Systems of other

manufacturers may be considered equal if, in the opinion, and the written approval of the engineer, they meet all the performance standards specified herein.

Materials

Metal Raceways: The raceway and all system components must be UL Listed. They shall be manufactured of steel; zinc plated, galvanized and/or finished in manufacturers standard color topcoat over gray primer base and shall be suitable for field repainting to match surroundings. The raceway shall be a one-piece design with a base and cover factory assembled. The raceway shall be available in 5' lengths.

Non Metal Raceways: The raceway and all system components must be UL Listed, two piece construction of rigid PVC or polymer compound with matte texture and manufacturers standard color.

Fittings. A full compliment of fittings must be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, and bushings. The fitting covers shall be painted with an enamel finish, manufacturers standard color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable. A transition fitting shall be available to adapt to other raceways.

Device and Fixture Boxes. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single and multiple gang configurations,

up to six gang in some cases by the use of an adaptor fitting. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. All device and fixture box covers shall be painted with an enamel finish, manufacturers standard in color to match the raceway cover.

Metal Wireways: Sheet metal sized and shaped as indicated, NEMA 1 , Including couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wireways as required fro complete system. Covers to be screw type. Finish to be manufacturers standard enamel.

C. EXECUTION:

Installation

Installer shall carefully layout the surface raceway system prior to and during installation to minimize offsets and superfluous fittings. Refer to manufacturer's list of standard components.

1) Mechanical Security. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, and cabinets, in accordance with manufacturer's installation sheets.

2) Electrical Security. All metal raceway shall be electrically continuous and bonded in accordance with the National Electric Code for proper grounding. A separate grounding conductor shall be routed with ungrounded conductors.

3) Raceway Support. Raceway shall be securely mounted to wall and supported at intervals not exceeding 3 feet. Toggle bolts or other approved anchors shall be utilized for means of attachment in tile or hollow wall construction. Lead anchors with screws in solid concrete applications.

4) Completeness. All raceway systems shall be installed complete, including insulating bushing and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.

16120 CONDUCTORS:

This Contractor shall furnish and install all wire and cable necessary to complete the work herein outlined and as shown on drawings, except such items as are specifically noted as being furnished by others. All wiring in the entire system must be color coded and all conductors shall have their size, voltage, manufacturer, and type clearly marked on the outer covering. All wire and cable shall be as herein specified or as shown on the drawings. Wire and cable shall be as manufactured by Okonite, Rome, Triangle, Southwire or approved equal.

A. CONDUCTORS:

Conductors shall consist of annealed copper wire of size indicated on drawings or as may be specified herein. No conductors smaller than #12 AWG copper shall be used, except as noted. All conductors up to conductors up to and including #10 AWG shall be solid copper and all conductors of #8 AWG and larger shall be copper of size indicated on drawings or as may be specified herein, Class B concentric stranded construction.

B. WIRE INSULATION:

All wire and cable unless otherwise specified shall be single conductor type XHHW, THW or THHN 600 volt insulation. Fixture drop wire to lighting fixtures shall be type AF. Where branch circuits are fed through fluorescent channels, type XHHW or type RHH wire may be used. Conductors shall be color coded - Black, red, blue, white on 208/120 volt systems, brown ,orange yellow on 480/277 volt systems.

Conductor sizing on drawings based on 75 deg c. rating of insulation.

C. INSTALLATION:

The Designer reserves the right to inspect any and all joints in wiring. If joint is already taped, Contractor will properly retape after inspection.

Conductors shall be continuous without joints or splices in runs between outlet boxes. All splices shall be made at boxes only.

D. SPLICES AND TERMINATIONS:

Splices shall be made by use of mechanical connectors of the following manufacturers' types: T & B, "Sta-Kon"; Burndy, "Crimpit"; Minnesota Mining & Manufacturing Co., "Scotchlock" Ideal, "Wing-Nuts". Conductors size #8 AWG and larger shall be spliced and connected with suitable solderless, mechanical lugs and connectors, such as T & B "Lock-Tite".

All splices, taps, and connections shall be insulated with Scotch electrical tape as made by Minnesota Mining & Manufacturing Company as applicable to installation.

16141 SWITCHES AND RECEPTACLES: Commercial

A. SWITCHES:

Switches shall be Bryant 4900, P & S 20AC1, Eagle 2221 or Leviton 1200, Series two, three or four-way as specified on drawings, 120/277 volt 20 amp., mounted 4'-O" A.F.F.

B. RECEPTACLES:

Receptacles shall be Bryant 5252 ,P& S 5252, Eagle 5252 or Leviton 5252, 15 amp., 125 volt, grounding type unless specifically noted on drawings.

Receptacles shall be grounded and bonded per N.E.C., Section 250-74.

Receptacle Wring: Connection to receptacle terminals shall be by single conductors to terminals, pigtailed from branch circuit conductors. **Use of receptacle terminals to loop circuits shall not be permitted.**

C. SPECIAL PURPOSE OUTLETS:

Receptacles with special configuration as shown on plans may be as manufactured by Hubbell, Bryant, Leviton, Eagle or Pass & Seymor or other approved equal in addition to numerical designation shown on plans.

16150 MOTORS/EQUIPMENT TESTING:

Furnish power wiring and disconnect switch for all equipment furnished by others.

This Contractor to furnish and install all disconnect switches where shown or required.

Inspect and clean all contacts if required in control panels, starters, and miscellaneous control devices and make all necessary adjustments and wiring changes as may be required for the proper operation of equipment.

Running tests shall be made on all equipment connected by this Contractor to check proper operation of equipment and verify installation of properly sized overcurrent relays. Such tests shall not be made; however, without the permission of a responsible party designated by the Owner. Tests will be made only in presence of Contractor or others furnishing equipment, if other than Electrical Contractor.

This Contractor shall connect and test all other equipment and shall provide cords and mating caps for receptacles where equipment is cord connected.

16170 DISCONNECT SWITCHES:

1) Switches shall be "Heavy Duty " type - size as called for on the drawings, in N.E.M.A. 1 or NEMA 3R enclosures, "Third Party" listed and labeled, complete with all fuses as required.

2) Switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "on " position.

3) Switches shall have handles whose positions are easily recognizable and are padlockable in the "on" or "off" position.

4) Switches shall have nonteasible, positive, quick make-break mechanisms.

5) Switches shall be properly labeled.

6) Fuses shall be non-renewable and manufactured by Bussman, Little Fuse or Chase-Shawmutt, and where rated above 30 amperes shall be of the dual element "Fusetron" type.

7) Switches to be exterior mounted shall be N.E.M.A. 3R enclosure.

8) Switches shall be provided by this Contractor where required to meet 2011 N.E. Code, or as shown.

9) Switches for air conditioning/heating equipment shall be fusible.

10) Where applicable for equipment with external control voltage source, switches shall be equipped with integral electrical interlocked disconnect switch, one or two pole as applicable.

11) Switches to be as manufactured by Square "D" as scheduled or equals by Cutler Hammer / Westinghouse, General Electric or Siemens - ITE.

16190 SUPPORTING DEVICES:

A GENERAL:

All secondary electrical devices (outlet boxes, speakers, bells, clocks, telephones, poles, bases, switches, receptacles, fixtures, etc.) shall be located generally as shown on drawings. This Contractor shall study the general building plans in relation to space surrounding each device to prevent interferences and when necessary he will relocate devices.

No device utilized by handicapped to be more than 4'-0" A.F.F. to top, unless specifically shown otherwise.

B. OUTLET AND SWITCH BOXES:

Outlet and switch boxes shall be code size and type, made of galvanized sheet steel and shall be properly supported.

Boxes installed in exposed masonry walls shall be a concealed job: intermediate oversize type plates

shall be used where standard plate will not cover opening. All adjacent plates shall match and be intermediate type also. Use of jumbo device plates will be avoided wherever possible. Extra deep boxes to be utilized on all brick areas.

All outlets shall be equipped with a stainless steel plate, type 302, Hubbell series 93000, Bryant Series 93000, P & S Series 93000 or Designer approved equal. All exterior mounted boxes shall have approved weather-proof while in use plates and/or covers. Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked ASuitable For Wet Locations While In Use@ and AUL Listed@. There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base to assure proper seal. TayMac; Specification Grade or engineer approved equal. All surface installed boxes shall have stamped steel device plates.

C. OUTLET LOCATIONS:

All outlets for fixtures, receptacles, switches, intercoms, clocks, telephone, etc., shall be installed in the location shown on the drawings. This Contractor shall study the general building plans in relation to the spaces surrounding each outlet in order that his work may fit the other work required by these specifications and plans as well as the work of other trades.

When necessary, this Contractor shall relocate outlets so that when fixtures or other fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Location must meet approval of Designer or be relocated at no cost addition by this Contractor.

Unless otherwise indicated on the prints, place top of outlet boxes at the following distances from finished floors:

Lighting & Power Panelboards - top of cabinet 6'-6" above floor.

Safety switches and/or circuit breakers - handle not over 6'-6" above floor.

Wall switches -4'-0" above floor.

Receptacles and telephone - l'6" above floor except where noted; and centered 6" above countertop to bottom of plate. Note architectural drawings for splash boards, tile, wainscoat, etc. above counter tops.

Thermostats - 4'-0" above floor.

Lighting Fixtures - as noted on drawings.

Speakers, clock receptacles - 7'6" above floor except where noted.

Boxes beside door shall be mounted so edge of trim is no closer than 2" from edge of door trim, and on strike side.

Fire alarm pull stations - 4'-0" above floor.

Fire alarm horn/lights - 80" to 96" " above floor.

When finished surfaces are brick, glazed tile, concrete masonry or similar material, outlet heights may be varied slightly on approval of Designer to fit into masonry courses with a minimum of cutting.

In roughing-in, all devices mounting heights are to be in compliance with the applicable provisions of the N.C. Building Code Volume 1-C regarding handicapped accessibility.

The Electrical Contractor is cautioned to review architectural, plumbing and heating plans to confirm

location of cabinet work and equipment and to adjust the exact installed location of receptacles and devices accordingly to avoid interferences between electrical devices, tile, and cabinet work or equipment. Responsibility for locating in field is Contractor's and Designer should be contacted for clarification before installation.

Lighting outlets shall be centered or spaced symmetrically as evidently intended, unless they are dimensioned. If any doubt arises, contact Designer for instruction before roughing in.

D. STRUCTURAL STEEL:

This Contractor shall provide miscellaneous structural steel necessary to mount electrical equipment to walls, beams and joists. All structural steel furnished shall be standard shapes and sizes and shall be free from rust and/or scale. All interior steel shall be firmly and rigidly welded or bolted in place. All structural steel shall be structural quality conforming with ASTM A7-497. All exposed or exterior steel shall be painted by this Contractor.

E. TAP AND PULL BOXES:

Boxes shall be of code gauge galvanized sheet steel but not less than 14 gauge metal. Holes for

raceways shall be drilled on the job. Where necessary for boxes to be supported away from the ceiling or beams, strap iron or threaded rod shall be used for supports.

1) Boxes shall have covers fastened on with screws. Sizes of boxes shall be determined by N.E.C. requirements.

2) In concealed wiring areas, install boxes flush with the finished surfaces and provide oversized covers.

3) Access shall be provided as shown on drawings or otherwise required.

4) Panels and boxes in fire rated walls shall be installed such as required to maintain fire wall construction, with appropriate layers of sheetrock or approved fireproofing compound behind them.

F. SECONDARY SYSTEMS:

Furnish and install all conduit, junction boxes, outlet boxes, and plates for conduit systems for telephone, communications, and other miscellaneous systems as shown on plans.

Leave a #14 AWG galvanized steel pull wire in each conduit for future use. Concerning the telephone system, the telephone supplier will furnish and install all telephone equipment such as hand sets, cables, terminal boards, etc.

This Contractor shall conform to their requirements as to bonds, box size, conduit size, power, plates, etc.

All unused outlet boxes shall be equipped with blank plates by this Contractor.

G. SUPPORTS IN DRYWALL OR PLASTER CONSTRUCTION: Outlet boxes, devices, fixtures mounted on drywall or plaster shall be secured using toggle bolts or to backing provided in wall prior to finishing. Plastic insert type devices are not acceptable.

16195 ELECTRICAL IDENTIFICATION

1. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, transformers, switchboards, motor control centers and other electrical equipment supplied for the project for identification of equipment, controlled, served, showing phase, voltage, etc. Nameplates shall be securely attached to equipment with self-tapping stainless steel screws, and shall identify equipment controlled,

attached, etc. Letters shall be approximately 1/2 inch high minimum. Embossed self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:

---- Blue surface with white core for 120/208 volt equipment.

---- Bright red surface with white core for all equipment related to fire alarm system.

---- Dark red (burgundy) surface with white core for all equipment related to security.

---- Green surface with white core for all equipment related to "emergency " systems.

---- Orange surface with white core for all equipment related to telephone systems.

---- Brown surface with white core for all equipment related to data systems.

---- White surface with black core for all equipment related to paging systems.

---- Purple surface with white core for all equipment related to TV systems.

2. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

3. All outlet boxes,junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined above. This includes covers above lift-out and other type accessible ceilings.

16452 GROUNDING:

All electrical systems and equipment connected under this contract shall be grounded in strict accordance with requirements set forth in the 2011 edition of the National Electrical Code and local regulations. Specific methods by which such return paths to earth are established may be dictated by local area conditions, system characteristics, or size.

Metal raceways, metal enclosures or electrical devices, switchgear enclosures, transformer frames, and other equipment shall be completely grounded in an approved manner prescribed by the N. E.

Code. All necessary conduit conductors, clamps, connectors, etc., for the grounding system shall be furnished, installed and connected by the Electrical Contractor.

An insulated green equipment grounding conductor, properly sized per NEC shall be run with all circuits

The electrical raceway system shall **not** be relied on for ground continuity.

Bonding shall be provided in accordance with Article 250, Section V of the 2011 edition of the National Electrical Code, and all service equipment shall be bonded up through and including the first overcurrent device.

Continuity shall be copper to copper in all cases

Where P.V.C. raceway is utilized, a properly sized copper bonding conductor shall be provided.

16721 FIRE ALARM SYSTEM:

A. Scope: This contractor shall tie to existing fire detection and alarm system as shown on drawings and described herein.

Systems shall be compatible with existing manufacture, and installed by a local fire alarm contractor who has at least 5 years of experience in installation of fire alarm systems.

B. Code Compliance: All fire and smoke detection and alarm system shall comply with the latest published revisions of NFPA 72, unless otherwise approved by the Engineer. They must also comply with the North Carolina State Building Code, which includes the National Electrical Code.

C. UL Compliance and Labeling: Comply with provision of UL safety standards pertaining to fire alarm systems; and provide products and components which are UL-listed and labeled.

D. Equipment:

1. All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:

Initiating Circuits, General.....Red (+)/White (-)

Initiating Circuits, Smoke Only.....Violet (+)/Gray (-)

Alarm Indicating Appliance Circuits.....Blue (+)/Black (-)

AHU Shutdown Circuits.....Yellow

Door Control Circuits.....Orange

Elevator Recall Circuits.....Brown

Permanent wire markers shall be used to identify all splices and terminations for each circuit. For splices, use markers or other means to indicate which conductor leads to the FACP.

2. There shall be NO splices in the system other than at terminal blocks. "Wire nuts" and crimp splices will NOT be permitted.

NOTE: All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

3. Wiring must be in metal conduit (3/4" minimum diameter), or surface metal raceway, unless waived by the Engineer. It shall be new AWG14 minimum stranded copper, type THHN/THWN. All junction boxes that are visible or accessible shall be painted red, unless

in finished areas.

4. Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any AC control wiring must be properly separated from other circuits and the enclosure must have an appropriate warning label to alert service personnel to the hazard.

5. All connections at the FACP must be made by the manufacturer's authorized, factory trained representative (rather than by the electrical contractor).

6. All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten megohms, verified with a megger.

E. Submittals: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Include operation and maintenance instructions for inclusion in maintenance manuals.

Provide shop drawings showing equipment/device locations and connecting wiring for entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams and risers are to be complete in all respects, showing number and color code of all wiring as well as terminal numbers for panel and junction box terminations.

Identify all zones with area/function served and designation(s) utilized on drawings, on all components and on all drawings or listing data. Panel drawings shall show specific system panel layout with location of all components as well as all terminal blocks for external wiring.

Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data in maintenance manual; in accordance with requirements of Section 16001-S.

F. System Testing and Certification

1. Upon completion of the installation, the CONTRACTOR AND THE MANUFACTURER'S AUTHORIZED REPRESENTATIVE together shall test every alarm initiating device for proper response and zone indication, every alarm signaling appliance for effectiveness, and all other functions such as elevator capture and control of smoke doors/dampers, HVAC systems, and pressurization fans.

ALL supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)

NOTE: The Engineer must be given advance notice of the tests, so that he and/or the owner may witness them if desired.

2. The contractor must submit the following test documentation:

(a) Measured sensitivity of each smoke detector.

(b) NFPA "Fire Alarm System Certification and Description".

After completion of the 100% system test and submission of the above documentation, the contractor will advise the ENGINEER that the system is ready for inspection. The system must operate for at least two days prior to this notice.

Equipment intended for open area protection or releasing device service may be subjected to simulated or actual test fires, in accordance with ANSI/UL guidelines and sound engineering practice, to verify proper response.

After successful completion of check-out, inspections, tests and acceptance, the warranty period begins. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Engineer may require a repeat of the Contractor's 100% system test. Continued improper performance during the warranty period shall be cause to require the Contractor to replace the system with equipment that will function properly.

3. System Documentation, Training, and Maintenance:

The contractor shall provide the Engineer with three copies of the following, to be forwarded to the owner:

(a) As-built wiring and conduit layout diagrams, including wire color code and label numbers, device identification (area/function served), drawing references, and showing all interconnections in the system, including terminal number in panels and at each intermediate terminal block..

(b) Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.

(c) Technical literature on all major parts of the system, including control panels, batteries, detectors, manual stations, alarm indicating appliances, power supplies, and remote alarm transmission means.

The manufacturer's authorized representative must instruct the owner's designated employees in proper operation of the system and in all required periodic maintenance. This instruction will include two copies of a written, bound summary, for future reference.

NOTE: Basic operating instructions shall be framed and mounted at the FACP.

The Contractor must have the manufacturer's authorized representative provide a quotation for regular preventive maintenance, in accordance with the recommendations of NFPA 72, "Guide for Testing Protection Signaling Systems". This will cover the first 12 months period after expiration of the standard warranty.

number in panels and at each intermediate terminal block..

NOTE: Basic operating instructions shall be framed and mounted at the FACP.

16850 HEATING/ AIR CONDITIONING AND VENTILATION:

A. HEATING AND AIR CONDITIONING EQUIPMENT:

Packaged air tempering units, and associated heating and air conditioning equipment will be furnished and installed by the Mechanical Contractor.

The electrical Contractor shall provide power wiring to equipment rooms or junction boxes in vicinity of such equipment.

The Electrical Contractor shall provide power wiring as outlined in section 16001 section "T".

The Mechanical Contractor shall furnish and install all thermostats, starters, controls, conduit, and wiring thereto. The Mechanical Contractor shall furnish fuses as required and overload heater elements for equipment and motors he installs.