

BERKELEY COUNTY HEALTH DEPARTMENT ADDITION AND ALTERATIONS

VOLUME 3 DIVISIONS 20 through 26 TECHNICAL SPECIFICATIONS

CRA PROJECT NO. 3702

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SECTION 200100 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

- A. The Advertisement for Bids, Instructions to Bidders, Bidding Requirements, General, Special and Supplementary Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. All manufacturers, suppliers, fabricators, contractors, etc. submitting proposals to any part if for work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.
- B. Each Proposer shall also be governed by any unit prices and Addenda insofar as they may affect his part of the work or services.
- C. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.
- D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

*** EDIT FOR GENERAL CONTRACTOR, CONSTRUCTION MANAGER, ARCHITECT**

- E. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor (or Construction Manager, if applicable), responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect (if applicable), then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.
- F. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.
- G. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that

interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

H. Definitions and Abbreviations

- (1) Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.
- (2) Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.
- (3) Architect - The Architect of Record for the project.
- (4) Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.
- (5) Provide - Furnish and install complete, tested and ready for operation.
- (6) Install - Receive and place in satisfactory operation.
- (7) Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.
- (8) Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
- (9) Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.
- (10) Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
- (11) OSHA - Office of Safety and Health Administration.
- (12) IBC - International Building Code.
- (13) The Project - All of the work required under this Contract.
- (14) NEC - National Electrical Code.
- (15) NFPA - National Fire Protection Association.

- (16) ASME - American Society of Mechanical Engineers.
- (17) AGA - American Gas Association.
- (18) SMACNA - Sheet Metal and Air Conditioning Contractors National Association.
- (19) ANSI - American National Standards Institute.
- (20) ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.
- (21) NEMA - National Electrical Manufacturers Association.
- (22) UL - Underwriters Laboratories.
- (23) ADA - Americans with Disabilities Act.
- (24) IMC - International Mechanical Code.
- (25) IECC - International Energy Conservation Code.
- (26) IFGC - International Fuel Gas Code.

I. Required Notices:

- (1) Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

2. INTENT

- A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.
- B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3. DRAWINGS AND SPECIFICATIONS

- A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to

complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.

- B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.
- C. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
- D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
- E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.
- F. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
- G. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

*** EDIT FOR DRAWING DISCIPLINES**

- H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.
- I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be

continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

- J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.
- K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.
- L. Special Note: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

4. EXAMINATION OF SITE AND CONDITIONS

- A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

- A. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall remunerate them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.
- B. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

- C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.
- D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK

- A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act for him.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

- A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.
- B. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.
- C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.
- D. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the

Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

- E. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.
- F. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the International Mechanical Code (IMC) and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association. Contractor shall secure a permit from the Division of HVAC. Final inspection certificate shall be provided by Contractor and a copy included in Operation and Maintenance Manuals.
- G. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.
- H. Where minimum code requirements are exceeded in the Design, the Design shall govern.
- I. The Contractor shall ensure that his work is accomplished in accord with the OSHA Standards and that he conducts his work and the work of his personnel in accord with same.
- J. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings and Construction, State of West Virginia and the American Disabilities Act.
- K. All work in conjunction with a natural gas installation shall, in addition to all other Codes, Rules, Regulations, Standards, etc., comply with the requirements of the local gas supplier and/or standards and recommendations of the American Gas Association.
- L. All work in relation to domestic water systems shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the requirements of the local water utility company and the adopted edition of the 10 States Standards.
- M. All work in relation to the installation of sanitary or storm sewers shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the local agency governing such installations and the adopted edition of the 10 States Standards.
- N. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings, and Construction, State of West Virginia and the American Disabilities Act.

8. EQUIPMENT AND PIPING SUPPORT

- A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

- A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

10. COST BREAKDOWNS (SCHEDULE OF VALUES)

- A. Within thirty days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

11. CORRECTION PERIOD

- A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.
- B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.
- C. All gas fired heat exchangers shall have 20-year warranty.
- D. All compressors shall have five-year warranty.

12. COMPUTER-BASED SYSTEM SOFTWARE

- A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

13. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

15. SURVEY, MEASUREMENTS AND GRADE

- A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.
- B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he shall promptly notify the Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

16. TEMPORARY USE OF EQUIPMENT

- A. The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineers. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.
- B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.
- C. A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.
- D. During all phases of construction:

- (1) Air Handling Units:

- a. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.
- b. On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.
- c. At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.

17. TEMPORARY SERVICES

- A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

18. RECORD DRAWINGS

- A. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically in AutoCAD 2007 format along with the hand marked field set to the Engineer. Electronic bid drawings will be furnished to the Contractor for his use.

19. MATERIALS AND WORKMANSHIP

- A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. In certain cases, it may be necessary to remove and replace walls, floors and/or ceilings and this work shall be the responsibility of the Contractor. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

- B. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.
- C. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.
- D. Each length of pipe, fitting, trap, fixture and device used in the plumbing or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.
- E. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

20. COOPERATION AND COORDINATION WITH OTHER TRADES

- A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than $1/4" = 1'-0"$, clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

21. QUALIFICATIONS OF WORKMEN

- A. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.
- B. All plumbing work shall be accomplished by Journeymen Plumbers under the direct supervision of a Master Plumber. Proof and Certification may be requested by the Engineer.

- C. All sheet metal, insulation and pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.
- D. All automatic control systems shall be installed by workmen normally engaged or employed in this type work, except in the case of minor control requirements (residential type furnaces, packaged HVAC equipment with integral controls, etc.) in which case, if a competent workman is the employee of this Contractor, he may be utilized subject to review of his qualifications by the Engineer and after written approval from same.
- E. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

22. CONDUCT OF WORKMEN

- A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workman to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption of alcoholic beverages or other intoxicants, narcotics, barbiturates, hallucinogens or debilitating drugs on the job site is strictly forbidden.

23. PROTECTION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

24. SCAFFOLDING, RIGGING AND HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

25. BROKEN LINES AND PROTECTION AGAINST FREEZING

- A. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping

across or near openings to the outside whether they are carrying static or moving fluids or not.
Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

26. CLEANING

- A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.
- B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

27. CONCRETE WORK

- A. The Contractor shall be finally responsible for the provisions of all concrete work required for the installation of any of his systems or equipment. He may, at his option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Mechanical work shall be 3000 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into floors to anchor pads.
- B. All mechanical equipment (tanks, heaters, chillers, boilers, pumps, air handling units, etc.) shall be set on a minimum of 4" tall concrete pads. Pads shall be taller where required for condensate traps. All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" round bars on 6" centers both ways. Bars shall be approximately 3" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all square edges one-half inch.
- C. In general, concrete pads for equipment shall extend four (4) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.
- D. Exterior concrete pads shall be four (4) inches minimum above grade and four (4) inches below grade on a tamped four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (1/2) inch chamfer on exposed edges.

- E. All exterior below grade concrete structures (utility vaults, grease traps, manholes, etc.) shall be provided with exterior waterproofing. Waterproofing shall be hot-fluid applied rubberized-asphalt waterproofing membrane with elastomeric sheets at edges, corners, and terminations of membrane for continuous watertight construction. Apply in layers and reinforce as required to provide uniform seamless membrane minimum 4mm thickness. Also, seal penetrations into and out of the structure watertight. Provide Link-Seal modular seal or equal.

28. NOISE, VIBRATION OR OSCILLATION

- A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at his expense.
- B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as small room heating units, small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.
- C. The Contractor shall provide supports for all equipment furnished by him. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineers.

29. ACCESSIBILITY

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.
- B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, etc.
- C. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

30. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, SURFACES, ETC.

- A. The Contractor shall at his expense restore to their original conditions all paving, curbing, surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item and shall be to the satisfaction of the Architect and/or Engineer.

31. MAINTENANCE OF EXISTING UTILITIES AND LINES

- A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily.
- B. Utilities and lines, where known, are indicated on the drawings. Locations and sizes are approximate. Prior to any excavation being performed, the Contractor shall ascertain that no utilities or lines are endangered by new excavation. Exercise extreme caution in all excavation work.
- C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation or blasting in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.
- D. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.
- E. The Contractor shall repair to the satisfaction of the Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
- F. Machine excavation shall not be permitted with ten feet of electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only.
- G. Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible.

32. SMOKE AND FIRE PROOFING

- A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the IBC. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

33. MOTORS

- A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C50, conforming to this and all applicable standards for insulation resistance and dielectric strength.
- B. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box, and N.E.C. required disconnecting means as specified or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.
- C. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 26 of Specifications for further requirements related to installation of motors.

34. CUTTING AND PATCHING

- A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.
- B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.
- C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

35. CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

- A. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.
- B. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- C. Seal all duct, pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is rated then use similarly rated sealing method.

36. WEATHERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

37. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

- A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.
- B. The Contractor shall furnish three (3) complete bound sets for delivery to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract prior to substantial completion. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs alone will not be acceptable for operating and maintenance instructions.
- C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.
- D. The Contractor shall frame under Lexan in the main mechanical room all temperature control diagrams and all piping diagrams.

38. PAINTING

- A. In general, all finish painting shall be accomplished under the Painting Section of the specifications by the Contractor; however, unless otherwise specified under other sections of these specifications, the following items shall be painted:
 - (1) All exposed piping, valve bodies and fittings (bare and insulated), including hangers, platforms, etc.
 - (2) All mechanical equipment not factory finished. Aluminum and stainless-steel equipment, motors, identification plates, tags, etc. shall not be painted. All rust and foreign matter shall be thoroughly removed from surfaces prior to painting. All baked enamel factory finish of equipment which may have been scratched or chipped shall be touched up with the proper paint as recommended and supplied by the manufacturer.
 - (3) All ductwork exposed in finished areas (bare and insulated), all grilles, diffusers, etc. not factory finished. Paint the inside surfaces of all interior duct surfaces visible from any register, grille or diffuser opening on all jobs; surfaces shall receive one (1) prime coat of Rustoleum 1225 red "galvinoleum" or other approved equivalent primer and rust inhibitor and one (1)

coat of Rustoleum 1579 jet black "Speedy Dry" enamel or approved equivalent applied in accordance with the manufacturer's recommendations.

- (4) All insulated piping, ductwork and equipment shall be properly prepared for painting by the Contractor where mechanical items are to be painted. In the case of externally insulated duct and pipe, the Contractor shall provide 6 oz. canvas jacket with fire retardant lagging. The jacket shall be allowed to dry properly before applying paint to avoid shrinking after painting and exposing unpainted surfaces. The Contractor, at his option, may provide double wall ductwork in lieu of externally insulated ductwork with canvas jacket and lagging.

39. ELECTRICAL CONNECTIONS

- A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.
- B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.
- C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.
- D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

40. FINAL CONNECTIONS TO EQUIPMENT

- A. The Contractor shall finally connect to mechanical services, any terminal equipment, appliances, etc., provided under this and other divisions of the work. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer's recommendations. If in doubt, contact the Engineers prior to installation.

41. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

- A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

42. INDEMNIFICATION

- A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

43. HAZARDOUS MATERIALS

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.
- B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.
- C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.
- D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

44. ABOVE-CEILING AND FINAL PUNCH LISTS

- A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:
 - (1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.
 - (2) For review of all other work as the project nears substantial completion.
- B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that

the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

- C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor at a rate of \$140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.



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The following is CMTA’s guide for Division 20-25 required information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job.

DIVISION 20-25 – MECHANICAL Field Representative: _____ Project Engineer: _____			
Description of Work	Scheduled Value	Labor	Material
Shop Drawings			
Mobilization/Permits			
Demolition			
Geothermal Horizontal Piping and Vault			
Geothermal Wells, Vertical pipe and grout			
Plumbing Underslab			
Sanitary Above Slab Rough-in			
Plumbing Fixtures			
Plumbing Inspections			
Sprinkler Plan Submittals			
Fire Protection Exterior			
Fire Protection Vault			
Fire Protection Interior			
Storm Piping Exterior			
Storm Piping Interior			
Plumbing Shop Drawings			

Mechanical Shop Drawings			
Domestic Water Piping			
Domestic Water Insulation			
Hydronic Piping			
Gas Piping Exterior			
Gas Piping Interior			
Steam Piping			
HVAC Sheet Metal			
Heat Pumps			
Boiler			
Chiller			
Cooling Tower			
Pumps & Assoc. Equipment			
Grilles & Diffusers			
Insulation			
Controls			
Air Balance			
Water Balance			
Chemical Treatment			
Boiler Inspection			
Factory Start-Up Reports			
Owner Training			
Record Drawings			
O & M Manuals			
Punchlist/Closeout			
Controls Check-out			

END OF SECTION 200100

SECTION 200200- SCOPE OF THE MECHANICAL WORK

1. GENERAL

A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:

- (1) Complete exterior domestic water service finally connected to the local domestic water system.
- (2) Complete exterior sanitary sewer system connected to the local system.
- (3) Complete exterior storm drainage system.
- (4) Interior domestic hot, cold and recirculating hot water system.
- (5) Interior soil, waste and vent systems.
- (6) Roof drainage system.
- (7) All plumbing equipment, fixtures and fittings.
- (8) 100% automatic sprinkler system.
- (9) All mechanical exhaust systems.
- (10) All insulation associated with mechanical systems.
- (11) Condensate drainage systems.
- (12) Complete heating, ventilation and air conditioning systems.
- (13) Final connection of all mechanical equipment furnished by others (e.g., kitchen equipment).
- (14) Complete balancing of air and water systems.
- (15) Complete natural gas piping systems.
- (16) All applicable services and work specified in Section 200100; General Provisions - Mechanical.
- (17) All specified or required control work.
- (18) Provide all required motor starters, etc. not provided under the electrical sections.

- (19) One year guarantee of all mechanical equipment, materials and workmanship.
- (20) Thorough instruction of the owner's maintenance personnel in the operation and maintenance of all mechanical equipment.
- (21) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.
- (22) Approved supervision of the mechanical work.
- (23) Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.
- (24) Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.
- (25) Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, Boiler, HVAC, etc.).
- (26) All necessary coordination with gas, water, and sewer utility companies, etc., to ensure that work, connections, etc., that they are to provide is accomplished.
- (27) Factory start-up of all major equipment (including terminal HVAC equipment) and submission of associated factory start-up reports to the Engineer.

END OF SECTION 200200

SECTION 200300 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS & TOOLS

1. GENERAL

- A. The Contractor's attention is directed also to the General and Special Conditions and Section 200100 - General Provisions - Mechanical as well as to all other Contract Documents as they may apply to his work.
- B. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, a minimum of seven (7) copies of all shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter.
- C. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.
- D. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.
- E. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
- F. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. Do not rely on the Engineer to "catch" items that do not comply with the Drawings or Specifications. The Contractor is responsible for meeting the Drawings and Specification requirements, regardless of whether or not something does not get caught by the Contractor or Engineer during shop drawing reviews.
- G. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in

the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

- H. If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.
- I. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.
- J. Shop Drawing Submittals
 - (1) All submittals for HVAC equipment shall include all information specified. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.
 - (2) All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.
 - (3) All items submitted shall be designated with the same identifying tag as specified on each sheet.
 - (4) Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

2. SHOP DRAWINGS

Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

- | | |
|---|------------|
| Duct Insulation (Internal and External) | Heat Pumps |
| Condensing units | |
| Air handling units | |
| Pipe Insulation | |
| Controls | |
| Water Heaters | |
| Hydronic Specialties | |
| (2) Chemical Treatment System | |
| (1) Pumps and Circulators (HVAC) | |

SPECIAL NOTES:

- 1) Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete copies

of operation and maintenance instructions and parts lists for each item marked (1) above. These documents shall include at least:

- a. Detailed operating instructions
 - b. Detailed maintenance instructions including preventive maintenance schedules.
 - c. Addresses and phone numbers indicating where parts may be purchased.
- 2) Shop drawings for the Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system.
 - 3) Shop drawings for the Building Fire Protection System shall be prepared and stamped by a Certified Contractor and shall meet the criteria of the Department of Housing, Buildings and Construction and submitted to the Engineer. After the Engineer's review, they shall be submitted by the Contractor to the proper state authorities along with the required State review fee.
 - 4) The Contractor shall submit to the Boiler Inspector's Office the required documentation and review fees for a boiler permit. The boiler permit shall be submitted to the Engineer along with the Boiler Shop Drawings.
 - 5) The Contractor shall submit shop drawings for the kitchen hood system(s) along with all required supporting documentation and review fees to the Department of Housing, Buildings and Construction and receive approval prior to submittal to the Engineers.
 - 6) The Contractor shall submit Material Safety Data sheets for all chemical treatment and anti-freeze solutions.

3. SPECIAL WRENCHES, TOOLS, ETC.

- (1) The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

4. BALANCE REPORTS

- A. Upon substantial completion of the project, the Contractor shall submit to the Engineers four (4) bound copies of the Certified Air and Hydronic Balance Report.

END OF SECTION 200300

SECTION 200400 - DEMOLITION AND SALVAGE

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

2. DEMOLITION

A. INTENT

It is the intent of this section to completely remove all components of any existing mechanical system no longer in use that will be open to view in, or will interfere with the operations of the completed building, or which will, in any way, interfere with project construction. Components of the existing mechanical systems which do not meet the above criteria, may be abandoned in place in a safe, workmanlike, code approved manner.

B. PLUMBING

- (1) All existing piping not to be reused, shall be removed when located in accessible chases, accessible ceiling spaces, crawl spaces, mechanical rooms, exposed, etc.
- (2) Unless otherwise indicated, the Contractor shall be responsible for patching and repairing all holes, etc. in the ceilings, walls, and floors where plumbing piping is removed.
- (3) All lines abandoned in place shall be made safe in compliance with the Internatinoal Plumbing Code.

C. HVAC

- (1) Remove from the project area all piping not to be reused and hangers, specialties, etc. that are accessible or that become accessible during construction and/or interfere in any way with any part of the construction or would be exposed in the completed building.
- (2) Remove all temperature controls and related items that are accessible or become accessible during construction.
- (3) Remove all existing heating and ventilating equipment not indicated to be reused from the building.
- (4) The Contractor shall be responsible for the removal and/or relocation of any HVAC piping, equipment, fittings, valves, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Structural, Mechanical or Electrical Systems at no increase in the contract price.

(5) Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where HVAC equipment is removed.

(6) Unless otherwise noted, when removing equipment sitting on a concrete pad, also remove the concrete pad and patch and repair floor to match adjacent surfaces.

D. REFRIGERANT RECOVERY

(1) The Contractor shall have a licensed refrigerant recovery technician evacuate all refrigerants from all refrigeration equipment being removed in accordance with EPA guidelines and regulations. The Contractor shall take all necessary precautions to not accidentally vent refrigerants to the atmosphere. The recovered refrigerant shall be offered to the Owner. If the Owner refuses it then it becomes the property of the Contractor.

E. THERMOSTAT, THERMOMETER, AND MERCURY BEARING DEVICE DISPOSAL

(1) The Contractor shall dispose of all mercury bearing materials in accordance with state and federal guidelines. The Contractor shall take all necessary precautions to not accidentally allow mercury to be released from the device during demolition.

3. SALVAGE

A. It is the intent of this section to deliver to the owner all components of any mechanical system which may be economically reused by him. The Contractor shall make every effort to remove reusable components without damage and deliver them to a location designated by the Owner.

B. Components to be delivered to the owner shall be specifically identified by the owner's representative prior to beginning the demolition. These components shall include, but are not limited to the following:

(1) Control air compressor and air dryer.

(2) Hydronic pumps.

(3) Exhaust Fans.

(4) Fire Protection Hose Stations.

(5) Water Coolers.

(6) Unit Ventilators.

C. Other items become the property of the Contractor and are to be removed from the site.

END OF SECTION 200400

SECTION 200500 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

- A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural and Structural drawings, to the end that complete coordination between trades will be affected. Special attention shall be given to the points where ducts or piping must cross other ducts or piping, where lighting fixtures must be recessed in ceilings, and where ducts, piping and conduit must fur into walls, soffits, columns, etc. It shall be the responsibility of the Contractor to leave the necessary room for other trades. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment found encroaching on space required by others.
- B. The Contractor shall be responsible for coordination with the Electrical trade to ensure that he has made provision for connections, operational switches, disconnect switches, fused disconnects, etc. for electrically operated equipment provided under this division of the specifications, or called for on the plans.
- C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other Contracts, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of piping, ductwork, conduit, and equipment not installed in accordance with the above instructions, and which interfered with work and equipment of other trades.
- D. In all areas where air diffusers and lighting fixtures are to be installed, the Contractor shall coordinate their respective construction and installations so as to provide combined symmetrical arrangements.

2. INTERFACING

The Contractor shall ensure that coordination is affected relative to interfacing of systems. Some interface points are (but not necessarily all):

- A. Connection of Domestic Water System to water service mains.
- B. Connection of Natural Gas System to natural gas service.
- C. Connection of Fire Protection System to domestic water service.
- D. Connection of Sanitary sewer house line to municipal service.
- E. Connection of Storm Drainage System to municipal system.

- F. Connection of fuel oil piping to emergency generator.
- G. Connection of Domestic Water System to Hydronic System.
- H. Connection of all controls to equipment.
- I. Electrical power connections to electrically operated (or controlled) equipment.
- J. Connection of Emergency Engine Exhaust System.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

- A. The Contractor shall make all connections to equipment furnished by others, or relocated from the existing structure, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.
- B. Supervision to assure proper functioning and operation shall be provided by the Contractor.
- C. Items indicated on the drawings as rough-in only (RIO) will be connected by others. The Contractor shall be responsible for rough-in provisions only.
- D. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.
- E. The Contractor shall be responsible for coordinating to determine any and all final connections that he is to make to equipment furnished by others.

4. COORDINATION DRAWINGS AND RECORD DRAWINGS

- A. RECORD DRAWINGS - Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, Architect and Engineer for their Records.

END OF SECTION 200500

SECTION 201100 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.
- C. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.
- D. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- E. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.
- F. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

2. SLEEVES, PLATES AND ESCUTCHEONS

- A. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.
- B. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

- C. At all other locations either pipe sleeves or core drilled openings are acceptable.
- D. Where thermal expansion does not occur, the wall may be sealed tight to the pipe or insulation.
- E. Insulation, that requires a vapor barrier (i.e., cold water or refrigerant piping, etc.), must be continuous through the sleeve/cored hole. For other piping, insulation may stop on either side of the sleeve.
- F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.
- G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.
- H. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.
- I. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

3. CUTTING

- A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.
- B. Mechanical, plumbing, and fire protection contractors shall coordinate all openings in new and existing masonry walls with the General Contractor; and, unless otherwise indicated on the Architectural drawings, provide lintels for all openings required for the work (Louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized as follows:
 - (1) New Openings under 48" in width: Provide one 3-1/2"x3-1/2"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
 - (2) New Openings 48" to 96" in width: Provide one 3-1/2"x6"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
 - (3) New Openings over 96" in width: Consult the Project Structural Engineer.

- C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.
- D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

4. PATCHING AND REPAIRING

- A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.
- B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.
- C. Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.
- D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.
- E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.
- F. Stainless steel collars shall be provided around all ducts, large pipes, etc., at all wall penetrations; both sides.
- G. Where ducts, pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to ensure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.
- H. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

END OF SECTION 201100

SECTION 201200 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall include all excavating, filling, grading, and related items required to complete his work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.
- C. Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2-0" to the side. Electric and fuel lines shall always be placed in a separate trench. All exterior lines shall have a minimum earth cover of thirty (30) inches to top of pipe, unless otherwise indicated.
- D. Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be encased for a distance not less than 5 feet on either side of the point of crossover.

2. SUBSURFACE DATA

- A. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavating to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. This paragraph is written to include the removal of all rock with no extras, whether rock is indicated or not.

3. BENCH MARKS AND MONUMENTS

- A. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

- A. Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of the pipe as narrow as practicable. Trench excavation for piping eight inches and smaller shall not exceed thirty-inch width for exterior lines and twenty-four-inch width for interior lines.
- B. Sheet and brace trenches as necessary to protect workmen and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in

Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

- C. Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineers. Machine excavation shall not be allowed within ten (10) feet of existing electric lines or lines carrying combustible materials. Use only hand tools.
- D. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the Contractor's expense.
- E. Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to ensure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell, or flange and/or is supported with blocks or wedges will not be accepted.
- F. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper jointing of pipe. Any water pumping from this Contractor's trenches which is required during construction, shall be included in this Contract.
- G. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be borne by the responsible Contractor.
- H. Use surveyor's level to establish elevations and grades.
- I. The Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation of his work.
- J. The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

- K. Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Mechanical Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

5. BACKFILL AND SURFACE REPAIR

- A. Backfilling for mechanical work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.
- B. Unless otherwise indicated or specified, all piping shall be bedded on four (4) inches minimum of compacted naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve on undisturbed soil excavated as described hereinbefore. Install tracer wire above pipe. Cover the pipe with twelve (12) inches of compacted backfill to prevent settlement above and around the new pipe. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Prior to placing this second level of backfill, apply all required coatings and coverings to pipe, apply required tests and check the grading of the pipe to ensure that it is correct and that the pipe is free of swags, bows or bends. Also check lines for leaks at this point and repair as required. Once all of the preceding is accomplished, continue backfill with clean, debris and rock free earth tamped at six (6) inch intervals. Finish the backfill as specified following. Note: Water settling of backfill will be permitted only as an aid to mechanical compacting.
 - (1) When installing any type of pipe below building footing, parallel or perpendicular to the footing, the area underneath the footing and in the zone of influence shall be backfilled with cementitious flowable fill. The zone of influence is the area within a 45-degree angle projecting down from the bottom edge of footers on all sides of the footing. Piping within flowable fill shall be isolated from the fill by a layer of heavy duty felt paper. Piping installed in trenches backfilled with flowable fill shall be anchored to the soil below prior to backfilling.
- C. Backfill beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.
- D. Backfill beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil.

* **REVIEW E, F, AND G BELOW FOR APPLICABILITY TO PROJECT.**

- E. Backfill for natural gas lines shall be in strict accordance with the utility company or local municipalities requirements. If in doubt, contact the utility company or local municipality and/or the Engineer.
- F. Backfill for lines carrying hazardous or combustible materials shall be in accordance with current codes, rules, regulations and safe practices. If in doubt, contact the Engineers.
- G. Backfill for underground tanks shall be in accord with the tank manufacturer's recommendations. If in doubt, contact the Engineers.
- H. Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.
- I. Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.
- J. Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.
- K. In the absence (if not specified or indicated elsewhere in the drawings or specifications to be done by others) of such work by others, the Contractor shall lay new sod over his excavation work. Level, compress and water in accord with sound sodding practice.
- L. When running any type of piping below a footer or in the zone of influence the piping shall be backfilled with cementitious flowable fill. The zone of influence is the area under the footer within a 45-degree angle projecting down from the bottom edge of the footer on all sides of the footer. Additionally, grease traps, manholes, vaults, and other underground structures shall be held away from building walls far enough to be outside of the zone of influence.
- M. Warning Tape and Tracer Wire

Provide a yellow and black plastic tape in all trenches 6" above the buried utility that identifies the utility about to be encountered. For non-metallic pipe a #12 copper wire shall also be laid in the trench to aid in future location of the piping. A foil faced warning tape may be used in lieu of the plastic tape and wire.
- N. All manholes, vaults, and similar underground structures shall have the top elevation set flush with finished grade unless specifically noted otherwise.

6. MINIMUM DEPTHS OF BURY (TO TOP OF PIPE)

In the absence of other indication, the following shall be the minimum depth of bury of exterior utility lines. (Check drawings for variations).

- A. Domestic Water Lines 36 inches.
- B. Fire Protection Lines 42 inches.
- C. Geothermal Lines 42 inches.
- D. Storm Lines 20 inches.
- E. Sanitary Lines (Exterior) 36 inches.
- F. Natural Gas Lines 36 inches.
- G. Fuel Oil Lines 36 inches.
- H. Other lines carrying combustible and/or hazardous materials 36 inches.

END OF SECTION 201200

SECTION 201300 - PIPE, PIPE FITTINGS AND PIPE SUPPORT

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.
- C. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-MECHANICAL). In metal buildings, support piping with standard pipe hangers with C-clamp connection to main structural members (not purlins), use angle steel cross pieces between main structural members where required to provide rigid support.
- D. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.
- E. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur, they shall be kept as close to walls as possible.

- F. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.
- G. All hot and cold-water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.
- H. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.
- I. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.
- J. All cast iron soil pipe and fittings shall be coated inside and out with coal tar varnish.
- K. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.
- L. Nipples shall be of the same material, composition and weight classification as pipe with which installed.
- M. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineers prior to submission of a bid proposal.
- N. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If necessary, contact Engineers.
- O. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case, shall be accomplished without use of insulating unions and permission of the Engineers.
- P. Apply approved pipe dope (for service intended) to all male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.
- Q. High points of closed loop hot water heating systems shall have manual or automatic air vents as indicated or required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.
- R. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.
- S. The entire domestic hot, cold and recirculating hot water piping system shall be sterilized in strict accord with requirements of the Department of Health Codes, Rules and Regulations for the State which the work is being accomplished in.

- T. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.
- U. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.
- V. Foam Core PVC is not permitted
- W. Where piping penetrates interior or exterior walls, the wall shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.
- X. Provide thrust blocks on all storm, sanitary, water, steam, hot, chilled, condenser, etc., and any other piping subject to hammering. Thrust blocks shall be provided at all turns.
- Y. All piping to hydronic coils shall be full size all the way to the coil connection on the unit. If control valve is smaller than pipe size indicated, transition immediately before and after control valve. Also, if coil connection at unit is a different size than the branch pipe size indicated, provide transition at coil connection to unit. On 3-way valve applications, the coil bypass pipe shall be full size.
- Z. Provide check valves on individual hot and cold-water supplies to each mixing valve (including each sensor style faucet, safety shower, mop sink, etc.) and each showerhead with a diverter valve (including all ADA showers). This requirement shall not be satisfied by mixing valves or fixtures with internal check valves. Independent external check valves are required.

2. UNIONS AND FLANGES AND WELDED TEES

- A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.
- B. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.
- C. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

- A. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.
- B. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.
- C. Cast iron soil pipe; ASA A-40.1 and CS 188-59.
- D. Cast iron drainage fittings; ASA B16.12.
- E. Cast iron screwed fittings; ASA B16.4.
- F. Welding fittings; ASA B16.9.
- G. Cast brass and wrought copper fittings; ASA B16.18.
- H. Cast brass drainage fittings; ASA B16.23.
- I. Reinforced concrete pipe; ASTM-C-76-64T.
- J. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.
- K. CPVC Plastic pipe; ASTM D2846.
- L. PVC plastic pipe; ASTM D1785.
- M. ABS plastic pipe; ASTM D1788-73.
- N. Cross-linked polyethylene (PEX) pipe; ASTM F876 and ASTM F877.
- O. Cross-linked polyethylene (PEX) fittings; ASTM F1960

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

- A. Interior Soil, Waste and Vent Piping:

1/4 inch per foot in direction of flow where possible but in no case less than 1/8" per foot.

- B. Exterior Sanitary Lines:

Not less than one (1) percent fall in direction of flow and no greater than indicated.

C. Roof Leaders:

1/8 inch per foot where possible.

D. Condensate Drain Lines from Cooling Equipment:

Not less than 1/4 inch per foot in direction of flow.

E. High and Low-Pressure Steam Mains:

One inch in 20 feet in direction of flow.

F. Steam Condensate Return Lines:

One inch in 20 feet in direction of flow.

G. Exterior Storm Lines:

Not less than 1 percent grade in direction of flow.

H. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

A. General Notes

- (1) Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.
- (2) Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.
- (3) PVC, CPVC, or plastic piping shall not be used under paving, roads or areas where vehicular traffic is expected.
- (4) PVC or plastic piping whether specifically listed or not may not be used in high rise buildings or anywhere else prohibited by code.

B. Sanitary Sewer – Exterior

- (1) Service weight cast iron piping with bell and spigot fittings complying with ASTM A 74. All joints shall be compression gasket type.

- (2) SDR 35 PVC pipe extruded from Type 1, Grade 1 polyvinyl chloride material. PVC pipe shall have a bell type fitting on one end. All joints shall be solvent cement type, made in accordance with the Kentucky Plumbing Code.
- (3) Service weight hubless cast iron with manufacturer's approved bands. Bands shall be heavy duty band with extra width for lateral support. Each coupling shall include a minimum for of four bands.

C. Storm Sewer – Exterior

- (1) Class II reinforced concrete pipe (RCP) with tongue and groove gasketed joints conforming to ASTM C-443.
- (2) Service weight cast iron piping with bell and spigot fittings complying with ASTM A 74. All joints shall be compression gasket type.
- (3) SDR 35 PVC pipe extruded from Type 1, Grade 1 polyvinyl chloride material. PVC pipe shall have a bell type fitting on one end. All joints shall be solvent cement type.

D. Domestic Water Piping - Exterior

- (1) Type "K" hard copper with wrought copper fittings and brazed joints.
- (2) Schedule 150 ductile iron piping with cement mortar lining and rubber gasketed joints.

E. Fire Protection - Exterior and Interior

Refer to the Fire Protection System section of these specifications.

F. Soil Waste and Vent Piping - General Requirements

- (1) Water closet floor flanges and ells shall be cast iron regardless whether PVC piping is allowed or not.
- (2) Soil and waste piping serving mechanical rooms, laundries and kitchens shall be cast iron regardless whether PVC piping is allowed or not. Cast iron will also be required at any other location where waste water temperature can exceed 120°F. Cast iron shall extend a minimum of 35' past last waste inlet.

G. Soil, Waste and Vent Piping (Below Slab)

- (1) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Kentucky Plumbing Code. **Foam core piping is not permitted.**
- (2) Service weight hubless cast iron with manufacturer's approved bands.

H. Soil, Waste and Vent Piping (Above Slab)

- (1) Service weight hubless cast iron pipe. Bands shall be heavy duty band with extra width for lateral support. Each coupling shall include a minimum of four bands.

I. Roof Leaders/Interior Storm Sewer Piping

- (1) Service weight hubless cast iron pipe with manufacturers approved bands. Horizontal pipe and fittings 6" and larger, shall be suitably braced to prevent horizontal movement. Provide bracing in accordance to CIPI 301-00. Provide "Holdrite" bracing system or approved equal.

J. Natural Gas Piping

- (1) Schedule 40 black steel pipe with malleable iron threaded fittings for pipe sizes 2" and smaller.
- (2) Schedule 40 black steel pipe with wrought steel butt welded fittings for pipe sizes 2-1/2" and larger.
- (3) Where gas pressure is 5 psi or greater, piping shall be schedule 40 black steel pipe with wrought steel butt welded fittings.
- (4) Gas piping on the roof shall have expansion loops on all piping runs 75 feet or greater.

NOTES:

- (1) All gas piping shall be installed per NFPA 54.
- (2) Unions or valves shall not be installed in an air plenum.
- (3) Piping below slab must be sleeved and vented.
- (4) Piping installed in concealed locations shall not have mechanical joints.

K. Domestic Cold, Hot and Recirculating Hot Water Piping (Above Slab)

- (1) Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).

L. Trap Prime Piping

- (1) Above slab: It shall match domestic water piping requirements.
- (2) Underslab: It shall match domestic water piping requirements with a protective wrap or cross-linked polyethylene (PEX) piping.

M. Domestic Cold, Hot and Recirculating Hot Water Piping (Below Slab)

Type "K" hard or soft copper tubing with wrought copper fittings and brazed joints. There shall be no joints beneath slabs.

N. Air Vent Discharge Lines

Type "L" soft copper; wrought copper fittings, 95/5 solder.

O. Condensate Drain Lines

(1) Type "DWV" copper, wrought copper, lead free solder.

(2) Schedule 40 PVC with solvent welded fittings.

P. Water Heater Relief Line

Type "M" copper tubing with sweat fittings and 95/5 solder.

END OF SECTION 201300

SECTION 201310 - WELDING

1. GENERAL

- A. All welding accomplished by the Contractor shall comply with provision of the latest revision of applicable codes, whether ASME Boiler and Pressure Vessel Code for pressure piping or such State and Local requirements as may supersede these codes.
- B. Welds shall be of sound metal thoroughly fused to the base metal at all points, free from cracks and reasonably free from oxidation blow holes and non-metallic inclusions. No fins or weld metal shall project within the pipe and should they occur they shall be removed. All pipe beveling shall be done by machine. The surface of all parts to be welded shall be thoroughly cleaned free from paints, oil, rust or scale at the time of welding, except that a light coat of oil may be used to preserve the beveled surfaces from rust.
- C. Pipe and fittings shall be carefully aligned with adjacent parts and this alignment must be preserved in a rigid manner during the process of welding.
- D. Each Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with specifications. If required by the Architect/Engineer, the Contractor shall cut out at least three (3) welds during the job for X-raying and testing. These welds shall be selected at random by the Resident Inspector and shall be tested as a part of the Contractor's Contract. Certifications of these tests and X-rays shall be submitted, in triplicate to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests.

2. WELDING QUALIFICATIONS

- A. It is required that all welding of piping covered by this specification, regardless of conditions of service, be installed as follows:
 - (1) Pipe welding shall comply with the provisions of the latest revision of the applicable codes, whether ASME Boiler and Pressure Vessel Code, ASA Code for Pressure Piping, or such state or local requirements as may supersede codes mentioned above.
 - (2) Before any pipe welding is performed, submit to the Owner or his authorized representative, a copy of the welding procedure specifications, together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction.
 - (3) Before any welder shall perform any pipe welding, submit to the Owner or his authorized agent the operator's qualification record in conformance with the provisions of the code having jurisdiction, showing that the operator was tested under the proven procedure specifications submitted.

- (4) Standard Procedure Specifications and Welders qualified by the National Certified Pipe Welding Bureau shall be considered as conforming to the requirements of these specifications.
- (5) "R" Stamp: Any welder performing modifications, repairs, etc. to boilers, pressure vessels, or other pressure retaining items shall have a current R stamp issued by the National Board of Boiler and Pressure Vessel Inspectors.
- (6) "PP" Stamp: Any welder working with steam systems exceeding 15 PSIG shall have a current PP stamp issued by ASME. This shall apply up to the first stop valve for single boiler installations and up to the second stop valve for multiple boiler installations.

B. MATERIALS

- (1) Welding fittings shall conform to ASA B16.9; of the same materials, thickness, etc., as the pipe being jointed; see ASA B36.10.

END OF SECTION 201310

SECTION 202100 - VALVES AND COCKS

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.
- C. All valves shall be designed and rated for the service to which they are applied.
- D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.
- E. Ball valves with temperature and pressure ports are not an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.
- F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts, Victaulic.
- G. All valves shall comply with current Federal, State and Local Codes.
- H. All valves shall be new and of first quality.
- I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.
- J. Angle stops for plumbing fixtures shall be quarter turn ball type.
- K. All valves for use in potable water systems shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

- A. At each plumbing fixture.

- B. At each air handling unit, and make-up air unit.
- C. At each unit heater.
- D. At each heating or cooling coil.
- E. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

- A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to ensure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. GATE VALVES

Gate Valves shall be of the wedge disc type, permit straight line flow, complete shut-off and designed so that when the valve is wide open, it can be packed under pressure. Valves 1-1/2 inches and smaller shall be bronze, with ends to suit piping and non-rising stem. The valve shall have a deep stuffing box for long contact with the stem, packing gland and filled with high quality packing. Valves 2 inches thru 4 inches shall be iron body bronze mounted with flanged ends and non-rising stem. Boiler stop valves and valves larger than 4 inches shall be iron body bronze mounted flanged ends with outside screw and yoke with rising stem. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 2" and under NIBCO T133, greater than 2" NIBCO F619. All gate valves 2" and smaller for use in potable water systems shall meet federal requirement to be lead free containing less than 0.25% lead by weight of wetted area. NIBCO F768B.

B. GLOBE VALVES

Globe Valves shall permit control of flow rate from full flow to complete shut-off and designed that when the valve is wide open it can be repacked under pressure, and have a deep stuffing box with gland and filled with high quality packing. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping union bonnet, and with stainless steel plug type disc and seat of not less than 500 Brinnell hardness. Valves 2 inches and larger shall be iron body bronze mounted with flanged ends, yoke bonnet, and disc guide. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 1-1/2" and under NIBCO T256AP, greater than 1-1/2" NIBCO F768B.

C. CHECK VALVES

Check Valves shall be horizontal swing type with two-piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure for bronze valves shall be 150 psi and iron valves 125 psi when installed in piping with system pressures up to 100 psi and 250 psi for 100 psi and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3" NIBCO F968B (for 100 psi or greater systems). Victaulic 716/779 check valves allowed with grooved piping system.

D. BALL VALVES (NON-POTABLE)

Ball Valves shall have removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blow out proof stem, bronze body, reinforced Teflon seats, chrome plated steel ball as manufactured by Consolidated Valve Industries, Inc., Lunkenheimer, Apollo, Jenkins, Nibco or equivalent. Provide a stem extension so that the base of the handle is 1/4" above the insulation similar to Nibseal. NIBCO T5800-70.

E. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2" and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Apollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is 1/4" above the insulation similar to Nibseal. NIBCO S-585-66-LF.

F. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5. Valves 6" and over shall have gear driven operators. 3" and under Victaulic 608N, greater than 3" Vic-300 butterfly valves allowed with grooved piping system. **DESIGNER: DELETE AUTOMATIC FLOW CONTROL VALVE REFERENCE TO 15P BELOW IF NOT ALLOWED.**

G. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4" and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted

with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage. **Note: Refer to Specification Section 230200-HVAC Equipment for automatic flow control balancing valves on terminal equipment.**

H. AIR COCKS

Straight nose; Lunkenheimer Fig. 476; bronze; tee handle; bent nose; Lunkenheimer Fig. 478, 125#; bronze; tee handle.

I. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

J. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

K. PACKED PLUG COCKS

2" and under; DeZurik Fig. 425-S; 175#; semi-steel; screwed. 2-1/2" and over; DeZurik Fig. 425-F; 175#; semi-steel; flanged.

END OF SECTION 202100

SECTION 202110 - ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. All mechanical equipment shall be installed in a manner which allows ready access to all components requiring service, adjustments, shutoff, etc.
- C. Filters shall be accessible, removable and replaceable without disconnecting mounting brackets, piping, wiring, etc.
- D. All oil cups, grease cups, grease fittings, etc. shall be accessible without disassembly of equipment, piping, ductwork, etc. (Extended oilers or grease fittings may be required).
- E. Provide access doors or panels for all equipment, valves, dampers, filters, fire dampers, etc. in concealed spaces not otherwise provided with suitable access. (Lay-in ceilings shall be considered acceptable access; splined or drywall ceilings shall not).
- F. All valves, unions, strainers, cleanouts, volume dampers, and test points shall be accessible.
- G. Access panels in lay-in ceilings shall be labeled with a lamacoid plate to indicate location of equipment, filters, valves, etc.
- H. Access panels in fire rated walls shall bear the same rating as the wall.
- I. Each fire damper shall be provided access through the duct to allow reset of the damper. This may be either a gasketed sheet metal panel over a suitable opening or a factory built access panel. The panel shall be at least one and one-half (1 1/2) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to ensure that it is air tight. Manually check the size and location of each of these openings to ensure that the fire damper may be manually reset by use of hand only.
- J. Contractor shall coordinate the finish of all access doors and panels installed in finished areas with Architect.

2. ACCESS DOORS

Refer to Sheet Metal and Flexible Duct section of the specifications.

END OF SECTION 202110

SECTION 202200 - INSULATION - MECHANICAL

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.
- C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

- A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

- A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.
- B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.
- C. All products and their packaging shall bear a label indicating above requirements are not exceeded.
- D. Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

4. GENERAL APPLICATION REQUIREMENTS

- A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.
- B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork are to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full

thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vapor seal, where required, will be accepted.

- C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, mechanical platform, mezzanine, penthouses, storage areas, unfinished rooms, etc. is to be considered as "exposed".
- D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.
- E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!
- F. All insulation shall be installed with joints butted firmly together.
- G. The Contractor shall ensure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

- (1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.
- (2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.
- (3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.
- (4) Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.
- (5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

- (1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180-degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket. Approved manufacturers are listed in Section 2 – Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

- (1) Domestic Cold Water, Lab High Purity Water, Lab Deionized Water
- a. Piping 3" or less – use 1/2" thick insulation. Provide an additional 1/2" layer of insulation 3" above and 3" below vertical pipe supports.
 - b. Piping 4" or greater – use 1" thick insulation.
- (2) Hydronic System Fill Lines from Domestic Cold Water - 1/2" thick.
- (3) Domestic 110°F Hot Water and 110°F Recirculating Hot Water. (If heat traced, see below)
- a. Piping 1 1/2" or less – use 1 1/2" thick insulation.
 - b. Piping 2" or greater – use 2" thick insulation.
- (4) Domestic 140°F Hot Water and 140°F Recirculating Hot Water. (If heat traced, see below)
- a. Piping 1 1/2" or less – use 1 1/2" thick insulation.
 - b. Piping 2" or greater – use 2" thick insulation.
- (5) Domestic Hot Water with Heat Tape for Heat Maintenance - Insulation thicknesses as required by the manufacturer to maintain water temperature.

(6) Horizontal Roof Leaders.

- a. Piping 3" or less – use 1/2" thick insulation
- b. Piping 4" or greater – use 1" thick insulation

(7) Sanitary Sewer and plumbing fixture P-traps to waste stack – see schedule below. Insulate horizontal runs which receive air conditioning condensate and which are not located below slab or grade.

- a. Piping 3" or less – use 1/2" thick insulation
- b. Piping 4" or greater – use 1" thick insulation

(8) Condensate Drain Lines.

- a. Piping 1 1/2" or less – use 1/2" thick insulation
- b. Piping 2" or greater – use 1" thick insulation

(9) Refrigerant Liquid and Suction Lines - Interior & Exterior

IMCOA, Nomaco, or Armacell closed cell polyethylene, 1.5 Lbs/Ft³ density, 0.24 BTU-Hr.-Ft³-°F/in at 75°F thermal conductivity, zero vapor permeance, 25/50 flame and smoke spread per NFPA 90 requirements. Elastomeric closed cell insulations that meet the above requirements are also allowed. Install insulation per the manufacturer's requirements. Provide UV protective coating for all exterior refrigerant lines.

- a. All pipe sizes: 1 1/2" thick

D. JACKETS

(1) Exposed (Mechanical Rooms, Interior Finished Rooms and Storage Rooms)

All insulated piping installed in the above areas shall have a canvas or PVC jacket:

- a. For all systems except steam, plenum rated PVC jacket equal to LoSmoke PVC jacket with flame/smoke rating of 25/50, ASTM-E84 test method. Minimum thickness 0.04 inches. Steam systems shall utilize plenum rated CPVC jacket with minimum thickness of 0.04 inches. Jackets shall be applied over top of specified pipe insulation. Approved equal manufacturers are Zeston and Speedline. Approved equal manufacturers are Zeston and Speedline.

(2) Exposed (Exterior)

In addition to the insulation specified for the exterior pipe, provide .016" aluminum jacket or PVC jacket 0.05" thick. The jackets shall be installed as recommended by the manufacturer

to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight. PVC jacket shall be Ceel-Co, Proto, or Zeston.

6. DUCTWORK SYSTEMS

A. GENERAL

- (1) Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.
- (2) Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to ensure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated only if indicated by details on the drawings.
- (3) All flexible duct connections on insulated ductwork shall be externally insulated.
- (4) All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

(EDIT B & C BELOW TO SUIT PROJECT)

B. EXTERNAL INSULATION

- (1) Supply Air
- (2) Return Air
- (3) Outside Air
- (4) Exhaust Air
- (5) Flexible Duct Connections on Internally Lined Ducts

Owens/Corning "Faced Duct Wrap - Type 100", or approved equal, 2" thick fiberglass duct wrap, 1.0 pcf density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2" thick insulation shall be 7.4 out of package and 6.0 installed.

Special Notes:

- a. Do not provide externally insulated duct per the above specification for any duct that is to be painted. Insulated duct that is to be painted shall be dual wall ductwork per specification Section 231200, Sheet Metal and Flexible Duct.
- b. Where supply, return, and outside air ductwork is routed through an unconditioned attic or any other space outside of the building thermal envelope, the ductwork shall be provided with a minimum of 2 layers of duct wrap for a minimum R value of 11.0. Additionally, this shall apply to exhaust ductwork on entering side of energy recovery type air handling units.

C. INTERNAL INSULATION DUCTWORK

(COORDINATE WITH 15-S – SHEET METAL. DELETE IF HIGH VELOCITY RECTANGULAR IS TO BE DOUBLE WALL).

(1) High velocity rectangular supply air.

- a. Duct liner shall be 1 ½” thick Owens/Corning, fiberglass duct liner with factory-applied edge coating or approved equivalent. The liner shall meet NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the airstream surface coating should contain an immobilized, EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .70 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .25 mean temperature. Minimum R value 6.0. All exposed fiberglass edges shall be sealed with super seal duct butter or edge treatment products in accordance with the manufacturer's recommendations.

The insulation shall be pinned to the duct per the manufacturer's recommendations for system air velocity. The black coated surface of the insulation shall face the air stream. The insulation liner shall receive an 100% coverage of adhesive to aid in attaching liner to the sheet metal. Provide metal nosing of the liner on the leading edge when system velocity exceeds 4000 FPM.

D. EXPOSED EXTERNALLY INSULATED DUCT

- (1) Round. 1 ½” semi-rigid fiberglass tank and pipe wrap with kraft aluminum foil all service jacket vapor barrier or PSK facing. K=.27 @ 75°F. Minimum R-value shall be OK. Provide 6 oz. canvas jacket with fire retardant lagging.
- (2) Rectangular. 1" rigid fiberglass industrial board with foil scrim kraft vapor barrier facing or PSK facing, 6.0 PCF density, K=.22 @ 75°F. Owens/Corning type 705. Provide 6 oz. canvas jacket with fire retardant lagging.

7. MECHANICAL EQUIPMENT

A. ROOF DRAIN SUMPS

- (1) Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22 at 75°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

B. FLOOR DRAIN SUMPS (Applies to all Floor Drains which Receive Air Conditioning Condensate and which are Installed in Locations Other Than Slab on Grade)

- (1) Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22

at 75°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

END OF SECTION 202200

SECTION 202300 - THERMOMETERS & OTHERS, MONITORING INSTRUMENTS

1. GENERAL

- A. The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated.

2. THERMOMETERS AND PRESSURE GAUGES

- A. All thermometers and gauges shall be readable from a standing position on the floor.
 - B. Thermometers shall be linear, alcohol filled, graduated in 1°F. Or less and shall have adequate range for service intended.
 - C. Pressure gauges shall be Bourdon Type, circular, 3" face, black letters on white face graduated in 2 PSI or less and shall have adequate range and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks.
 - D. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc., with flexible tubing.
 - E. Mount thermometers in approved wells and install with thermal grease. Do not make direct contact of base with fluid in pipe.
 - F. Gauges and thermometers shall be Marsh, Marshalltown, Weksler or equivalent.
3. Provide, when indicated on the plans, on the inlet and outlet of each terminal unit, a "Pete's Plug" or equivalent pressure/temperature test station. Furnish two (2) matching thermometers and pressure gauges to the owner upon project completion.

END OF SECTION 202300

SECTION 202400 – IDENTIFICATIONS, TAGS, CHARTS, ETC.

1. GENERAL

- A. The Contractor’s attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. VALVE TAGS AND CHARTS

- A. Provide and install on each valve in the Mechanical Systems a 1-1/2” diameter circular brass tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with letter and number identifiers as to system and purpose respectively. Letter identifiers shall be as follows:

H	Heating
C	Cooling
HC	Combination Heating/Cooling
DCW	Domestic Cold Water
DHW	Domestic Hot Water
RHW	Recirculating Hot Water
HPS	High Pressure Steam
MPS	Medium Pressure Steam
LPS	Low Pressure Steam
HPC	High Pressure Steam Condensate
MPC	Medium Pressure Steam Condensate
LPC	Low Pressure Steam Condensate
FP	Fire Protection
FOS	Fuel Oil Supply
FOR	Fuel Oil Return
NG	Natural Gas

Number identifiers shall be determined by the Contractor sequentially. For example, valve No. HC-1 may be maintenance stops for fan coil units. HC-2 maintenance stops for air heaters, etc.

- B. Provide three (3) copies of typewritten valve charts indicating each valve identifier, the valves purpose and its location. For example: “HC-1 Fan Coil Maintenance Stop-one valve at supply and return of each fan coil unit.” One (1) copy of this chart shall be mounted in suitable wood frame(s) with clear plastic or glass covers in a conspicuous location in the Mechanical Room. Two other copies shall be turned over to the Engineers.
- C. Where more than one major Mechanical room is indicated for the project, install mounted valve schedule in each major Mechanical Room, and repeat only main valves which are to be operated in conjunction with operations of more than single Mechanical Room.

OR

D. All valves must have labels, both a tag on the valve and on the ceiling grid. All labels for valves must be on ceiling grid (see UK's standard for lettering below). **(UK ONLY)**

E. UK's Standard for Standard Lettering:

Attach Seton-Ply Discs to ceiling grid under equipment or to access doors in non-accessible ceiling. **(UK ONLY)**

EQUIPMENT: COLOR:	ENGRAVES:
Valve Yellow	V.
Fire Damper Black	F.D.
Smoke Damper Black	SM.D.
Volume Damper Black	V.D.
Terminal Unit Red	T.
Variable Volume Unit Red	V.V.
Heating Coil Blue	H.C.
Cabinet Unit Heater Red	C.H.

3. PIPING IDENTIFICATION

A. GENERAL

(1) Provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking. The following table describes the size of the color field and size of the identification letter which shall be used for pipes of different outside pipe diameters.

OUTSIDE DIAMETER OF PIPE OR COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS
INCHES	INCHES	INCHES
3/4 TO 1-1/4	8	1/2
1-1/2 TO 2	8	3/4
2-1/2 TO 6	12	1-1/4
8 TO 10	24	2-1/2
OVER 10	32	3-1/2

(2) "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

(3) All piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where lines pass through walls or floors.

(4) Provide pipe marker colors as indicated in the following table where manufactured marking systems are used:

<u>PIPE+</u>	<u>MARKER COLOR+</u>	<u>ABBREVIATION</u>
Chilled Water Supply*	Green with Black Letters	C.W.S.
Chilled Water Return	Green with Black Letters	C.W.R.
Hot Water Supply*	Yellow with Black Letters	H.W.S.
Hot Water Return	Yellow with Black Letters	H.W.R.
Chilled/Hot Water Supply*	Green with Black Letters	C.H.W.S.
Chilled/Hot Water Return	Green with Black Letters	C.H.W.R.
Steam (Low, Medium & High Pressure)	Yellow with Black Letters	LPS, MPS, HPS
Condensate (Low, Medium & High Pressure)	Yellow with Black Letters	LPC, MPC, HPC
Domestic Cold Water	Green with Black Letters	D.C.W.
Domestic Hot Water	Yellow with Black Letters	D.H.W.
Recirculated Hot Water	Green with Black Letters	R.H.W.
Compressed Air	Blue with White Letters	C.A.
Natural Gas	Yellow with Black Letters	NAT. GAS
Propane Gas	Yellow with Black Letters	PROP. GAS
Fuel Oil (Supply, Return, Fill & Vent)	Yellow with Black Letters	FOS, FOR, FOF, FOV
Sanitary Sewer Piping	Green with Black Letters	SAN.
Sanitary Vent Piping	Green with Black Letters	VENT
Storm Sewer Piping	Green with Black Letters	STORM
Fire Protection Water	Red with White Letters	F.P.

A. Piping, whether exposed or concealed, shall be marked not less than every 15 linear feet and at the points where the piping passes through wall or floors.

B. In mechanical rooms, piping shall be labeled every 10 feet.

4. PIPE PAINTING (REFER ALSO TO ARCHITECTURAL SECTION ON PAINTING)

A. GENERAL

(1) All exposed piping installed shall be painted according to the color-coding chart hereinafter specified.

- (2) “Concealed”, where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. “Exposed” shall mean that piping or equipment is not “concealed” as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as “exposed”.
- (3) Paint all equipment and metal surfaces which are not factory finished (and all damaged or rusted surfaces) in high grade rust proofing machinery enamel. Pay particular attention to flanges, valves, unions, etc., where condensation may collect.
- (4) Paint exposed pipe (whether insulated or bare) and exposed surfaces (tanks, etc.).
- (5) All piping shall be painted in accordance with the following color-coding chart.

<u>PIPE+</u>	<u>PIPE COLOR CODE+</u>	<u>ABBREVIATION</u>
Chilled Water Supply*	Green with Black Letters	C.W.S.
Chilled Water Return	Green with Black Letters	C.W.R.
Hot Water Supply*	Yellow with Black Letters	H.W.S.
Hot Water Return	Yellow with Black Letters	H.W.R.
Chilled/Hot Water Supply*	Green with Black Letters	C.H.W.S.
Chilled/Hot Water Return	Green with Black Letters	C.H.W.R.
Steam (Low, Medium & High Pressure)	Yellow with Black Letters	LPS, MPS, HPS
Condensate (Low, Medium & High Pressure)	Yellow with Black Letters	LPC, MPC, HPC
Domestic Cold Water	Green with Black Letters	D.C.W.
Domestic Hot Water	Yellow with Black Letters	D.H.W.
Recirculated Hot Water	Green with Black Letters	R.H.W.
Compressed Air	Blue with White Letters	C.A.
Natural Gas	Yellow with Black Letters	NAT. GAS
Propane Gas	Yellow with Black Letters	PROP. GAS
Fuel Oil (Supply, Return, Fill & Vent)	Yellow with Black Letters	FOS, FOR, FOF, FOV
Sanitary Sewer Piping	Green with Black Letters	SAN.
Sanitary Vent Piping	Green with Black Letters	VENT
Storm Sewer Piping	Green with Black Letters	STORM
Fire Protection Water	Red with White Letters	F.P.

* Includes pumps, air separator, valves, compression tanks, etc.

+ Where a pipe is not specifically identified in this table, painting and marking shall be in accordance with the most recent ANSI Standards.

- B. Water heaters, storage tanks, heat exchangers, etc., shall be painted light gray.
- C. All piping shall be marked. Piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where the piping passes through wall or floors.

5. EQUIPMENT IDENTIFICATION

- A. 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 than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. Lamacoid plates are also acceptable. In finished rooms or outdoors, equipment shall be identified by engraved nameplates.

6. DUCTWORK IDENTIFICATION

- A. All ductwork shall be identified as to the service of the duct and 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.

7. ACCESS THROUGH LAY-IN CEILINGS

- A. Mark the ceiling T-bar nearest the ceiling panel access to equipment, valves, damper, filter, duct heaters, etc., with a small red lamacoid plate with name of item above ceiling.

END OF SECTION 202400

SECTION 202500 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. Each Contractor's attention is also directed to Section 201300, Pipe, Pipe Fittings and Pipe Support.
- C. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.
- D. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

2. MATERIALS AND EQUIPMENT

- A. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I-beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.

6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.
7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18-gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.
16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and

		fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved equivalent, P-3245. Design load 1000 lbs.

3. INSTALLATION

A. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:

- (1) Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.
- (2) For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power-driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.
- (3) Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.
- (4) Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.
- (5) Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.
- (6) Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

- (7) Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.
- (8) Support all ceiling hung equipment, with approved vibration isolators.
- (9) Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.
- (10) Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.
- (11) All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.
- (12) Under no conditions will perforated band iron or steel wire driven hangers be permitted.
- (13) In general, support piping at the following spacing:
 - a. Steel and copper piping - 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 1/4" and 1" pipe. 8-foot intervals for piping 1 1/2" to 3". 10-foot intervals piping 3 1/2" and larger.
 - b. PVC piping – 4-foot intervals for piping 1 1/2" and smaller. 5-foot intervals for 2 and 2 1/2" piping. 6-foot intervals for 3" pipe and larger.
 - c. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

END OF SECTION 202500

SECTION 202600 – MECHANICAL/ELECTRICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS

1. GENERAL

A. RELATED DOCUMENTS

- (1) Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and Division 1 Specifications Sections, apply to this section.

B. MANUFACTURERS

- (1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:

Mason Industries
Vibration Eliminator Co., Inc.
Vibration Isolation Co., Inc.
Kinetics Noise Control
Vibration Management Corporation - Vimco

All Seismic restraint devices; isolators, calculations and seismic design shall be provided by a single vibration isolator manufacturer as listed above.

C. SUMMARY

- (1) This Section includes vibration isolators, vibration isolation bases, and seismic restraints and snubbers for mechanical and electrical equipment, duct and piping systems.

Drawings and calculation
Certification of seismic restraint designs
Installation supervision

D. PROJECT CONDITIONS

- (1) Building Classification Category is III (2015 IBC – Table 1604.5).
- (2) Seismic Design Category: D
- (3) Seismic calculations, design and installation for Mechanical Systems shall be per ASCE Standard 7, Minimum Design Loads for Buildings and Other Structures, 2005 edition, chapter 13.

NOTE TO DESIGNER: Edit component importance factor below for various systems/components. Fire protection, emergency power (where code required), smoke evacuation, life safety systems, gas pipe, gas-fired equipment, medical gas (even in non-medical facility), etc. is always 1.5. If bldg is occupancy category I, II, or III, all other M&E systems can be reduced to 1.0. All M&E systems in occupancy category IV are 1.5.

(4) Component Importance Factors shall be as follows:

1. 1.5 for all Fire Protection Systems, Natural Gas Piping, & Gas-Fired Equipment.
2. 1.0 for all other Mechanical & Electrical systems & equipment.

a. The interrelationship of components and their effect on each other shall be considered so that the failure of any essential or non-essential architectural, mechanical or electrical component shall not cause the failure of another essential architectural, mechanical or electrical component.

(5) Duct restraints are not required if conditions of ASCE 7-05; Chapter 13 paragraph 13.6.7 are met.

(6) Piping restraints are not required if conditions of ASCE 7-05; Chapter 13; paragraph 13.6.8 are met.

(7) Fire Protection Sprinkler Systems: Refer to ASCE 7-05; Chapter 13, paragraph 13.6.8.2 and 13.6.8.3.

E. APPLICABLE CODES AND STANDARDS

(1) The International Building Code; 2015; Chapter 16, 17

(2) ASCE 7-05, Chapter 13.

F. SUBMITTALS

(1) Product Data: Indicate types, styles, materials, and finishes for each type of isolator and seismic restraint specified. Include load deflection curves.

(2) Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.

G. SEISMIC RESTRAINT SUBMITTALS

(1) Shop Drawings: Show designs and calculations, prepared and stamped by a licensed professional engineer, for the following:

a. Design Calculations: Calculations for design and selection of seismic restraints for equipment (including fire pump and related equipment), duct and piping systems (including risers), stamped by a licensed professional engineer.

b. Analysis must include calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/ or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in

listed building codes acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

- c. Seismic Restraint Details: Detail fabrication and attachment of restraints and Snubbers.
- d. Concrete Pad Details: Show required concrete pad size and location for equipment. Show locations of required pad anchors and stud wedge anchors.
- e. Where wall, floors, slabs, or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

H. SEISMIC RESTRAINT QUALITY ASSURANCE

- (1) Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who has a minimum of 5 years experience in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent.

2. PRODUCTS

A. VIBRATION ISOLATORS

- (1) Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top-and baseplates. Factory drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.
- (2) Restraint Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.
- (3) Housing: Welded steel or ductile iron. Factory-drilled baseplate for bolting to structure and bonded to a 1/4 -inch-(6mm) thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.
- (4) Outside Spring Diameter: Not less than 80 percent of the compressed height of spring at rated load.
- (5) Minimum Additional Travel: 50 percent of the required deflection at rated load.
- (6) Lateral Stiffness: More than 0.8 times the rated vertical stiffness.
- (7) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

- (8) Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.
- (9) Vertical Limit Stops: Where required or shown, provide resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed.
- (10) Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.
- (11) Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.
- (12) Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
- (13) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- (14) Minimum Additional Travel: 50 percent of the required deflection at rated load.
- (15) Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- (16) All-directional acoustical pipe anchor shall consist of two sizes of steel tubing separated by a minimum ½" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
- (17) Seismic solid braces shall consist of steel angles or channels to resist seismic loads with minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connection shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number OSHPD in the state of California verifying the maximum certified load ratings.
- (18) Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for rebar to pass through. The anchor should be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping anchors shall be attached to the structural slab using stud wedge anchors.
- (19) Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that was "rolled up" to create the thread. The stud anchor shall also have a safety shoulder, which fully support the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying its allowable loads.

- (20) Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying to its allowable loads.

B. VIBRATION ISOLATION BASES

- (1) Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.
- (2) Fabricate bases to shapes required, with welded structural-steel shapes, plates and conforming to ASTM A 36 (ASTM A 36M). Include support brackets to anchor base to isolators units. Include pre-located equipment anchor bolts and auxiliary motor slide bases or rails.
- (3) Design and fabricate bases to result in the lowest possible mounting height with not less than an inch (25-mm) clearance above the floor.
- (4) Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.
- (5) Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.
- (6) Configure inertia bases to accommodate equipment supported.
- (7) Pump Bases: Size to support pump and piping elbows.
- (8) Factory Finish: Manufacturer's standard corrosive-resistant finish.

C. SEISMIC CONTROLS

- (1) Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.
- (2) Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
- (3) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- (4) Minimum Additional Travel: 50 percent of the required deflections at rated load.
- (5) Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- (6) Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

- (7) Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges.
- (8) Manufactured Seismic Snubbers: All-directional, double-acting snubbers
- (9) Construction: Interlocking steel members restrained by $\frac{3}{4}$ -inch-(19-mm-) thick, replaceable, shock-absorbing neoprene insert. Maintain $\frac{1}{8}$ inch (3mm) clearance in all directions between rigid and resilient surfaces.
- (10) Fabricated Seismic Snubbers: Welded structural-steel designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.
- (11) Construction: Welded steel shapes conforming to ASTM A 36 (ASTM A 36M)
- (12) Resilient Components: $\frac{3}{4}$ inch-(19-mm-) thick, replaceable, shock-absorbing neoprene insert.
- (13) Flexible Stainless-Steel Hose: Hoses shall be installed on equipment side of shut-off valves horizontally and parallel to the equipment shafts wherever possible.
 - a. Construction: Stainless steel braid and carbon steel fittings.
 - b. Connection: Less than 3": Male nipples.

3. EXECUTION

A. INSTALLATION

- (1) Install and anchor vibration-, sound-, and seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.
- (2) Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.
- (3) Filled concrete inertia bases, after installing base frame, with 3000-psig (20.7-Mpa) concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in Division 3.
- (4) Isolate duct as follows:
 - a. Provide spring and neoprene hanger or floor spring mount on all duct discharge runs for a distance of 50' from the connected equipment. Spring deflection shall be a minimum of 0.75".

- b. Provide pre-compressed spring and neoprene hanger or floor spring mount on all duct runs having air velocity of 1000 fpm or more. Spring deflection shall be a minimum of 0.75”.

(5) Isolated piping as follows:

- a. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be pre-compressed spring and neoprene type. Floor supported piping shall rest on spring type isolators. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75” deflection for pipe sizes up to and including 3”, 1 ½” deflection for pipe sizes up to and including 6”, and 2 ½” deflection thereafter.
- b. Riser isolation: Risers shall be suspended from spring and neoprene hangers or supported by floor spring isolators, all-directional acoustic pipe anchor, and pipe guide. steel springs shall be a minimum of 0.75” except in those expansion locations where additional deflection is required to limit load changes to +25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

B. SEISMIC CONTROL

- (1) All mechanical systems are to be seismically restrained. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical (equipment not listed is still included in this specification).
- (2) Ductwork, where seismically restrained, must be reinforced. Reinforcement shall consist of all additional angel on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
- (3) Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.
- (4) Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubber as close as possible to the vibration isolators and bolt to supporting structure.
- (5) Manufacturer shall provide installation instructions, drawings and trained field supervision to ensure proper installation and performance. Visit the project site before installation is begun and instruct installers in correct installation procedures for vibration isolation, seismic restraints and concrete pads. Observe installation of other work related to vibration isolation and seismic work, including concrete pad installations; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover the following:

- a. Equipment installations (performed as work of other sections) on vibration isolators and Seismic restraints.
 - b. Piping connections including flexible connections.
 - c. Ductwork connections including provisions for flexible connections.
 - d. Passage of piping and ductwork which is to be isolated through walls and floors.
 - e. Installation of isolators and seismic restraints on duct and piping systems.
- (6) Do not start-up equipment until inadequacies have been corrected in manner acceptable to Vibration Isolator and Seismic Controls Manufacturer.
- (7) Spacing for restraints shall be as follows, except where lesser spacing is required to limit anchorage loads:
- a. Ductwork and electrical services (conduit, bus ducts, cable trays, and ladder trays) transverse restraints shall occur at 30' intervals (or at both ends of the duct run if less than specified interval) and longitudinal restraints shall occur at 60' intervals (with at least one restraint per duct run). Transverse restraints shall be installed at each duct/electrical service turn and at each end of a duct/electrical run.
 - b. Walls including gypsum board non-bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

END OF SECTION 202600

SECTION 203100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

- A. The General Conditions, Instructions to Bidders, Section 200100, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor's responsibility to apprise himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.
- B. The Engineer, or his authorized representative, shall be notified by the Contractor twenty-four (24) hours in advance of any tests called for in these specifications or required by others. Any leaks or imperfections found shall be corrected and a new test run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

2. PLUMBING

- A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.
- B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The system shall be proven tight after a twenty-four (24) hour test.
- C. The house drain line, interior storm sewers, interior rain water conductors, and all soil, waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 lbs. per sq. inch using a mercury column gauge and shall hold for 15 minutes.
- D. Exterior sewer lines to the termination point outside the building shall be subject to a ten-foot hydrostatic test or an approved smoke test. These lines shall be subjected to a second test after 2 feet of backfill has been properly installed.
- E. After fixtures have been installed, the entire plumbing system, exclusive of the house sewer, shall be subjected to an air pressure test equivalent to one-inch water column and proven tight. The Contractor responsible shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.
- F. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.
- G. The Contractor shall perform all additional tests that may be required by the West Virginia Department of Health or other governing agency.

- H. Set temperature control on water heaters and adjust tempering valves as required.
- I. Balance the water flow rate of each domestic hot water recirculating pump. Set the flow rate for each balancing valve in the recirculating hot water system. If flow rates are not indicated, contact the engineer for each balance valve GPM.
- J. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.
- K. The compressed air system shall be tested for leaks for eight (8) hours at 250 PSI.
- L. The natural gas piping shall be tested in accordance with requirements and/or recommendations of the local gas company.
- M. Fuel oil piping shall be static tested at 250 PSI for eight (8) hours.

3. HEATING, VENTILATING AND AIR CONDITIONING

- A. The test and balance of this system shall be by a contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The test and balance contractor shall report all deficiencies to the engineer.
- B. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.
- C. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.
- D. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.
- E. All fan belts shall be adjusted for proper operation of fans.
- F. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.
- G. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:

- (1) The supply, return and outside air duct systems associated with (RTU-1). Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the return duct inlet and supply duct outlet of the air handling unit. Show accurate representation of return, relief, outdoor and economizer damper locations. On units equipped with return air fans; show location and profile of the return fan.
 - (2) Verify that the temperature control systems supply and return air flow stations on RTU-1 are calibrated corrected. Test at 25%, 50%, 75% and 100% flow rated.
 - (3) Verify calibrations of the duct static pressure sensors for RTU-1.
 - (4) Set the minimum and maximum air flow rates for each VAV and CAV box.
 - (5) Balance all supply, return and exhaust air grille to within 10% of design air flow rate.
 - (6) Balance all supply, return and exhaust air grilles to within 5% for critical rooms such as operating rooms, ICU, L&D, Isolation, Nursery and Trauma.
 - (7) Balance all exhaust air fans and record inlet static pressure.
 - (8) Balance the kitchen range hood supply/exhaust air system.
 - (9) Balance domestic hot water return system including all balance valves and record settings and flows.
 - (12) Adjust all adjustable diffusers to minimize air drafts and eliminate suspended light fixture sway. Furthermore, adjustable diffusers in spaces with ceilings taller than 9 feet shall be adjusted to eliminate air stratification during heating season.
- H. Provide a preliminary test report to the mechanical engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Anticipate visiting the site again after the engineer has reviewed the report. The engineer may request up to 15 additional static pressure measurements for any air handling system to help resolve any balancing deficiencies. Include five additional static pressure measurements for each exhaust air system.
- I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings such as gymnasiums, auditoriums, atriums, cupolas, etc. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.
- J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.
- K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.

L. Four (4) copies of the complete test reports shall be submitted to the Consulting Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

M. The Contractor shall provide and coordinate their work in the following manner:

(1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.

(2) Provide immediate labor and tools to make corrections when required without undue delay.

N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and range hood system into full operation and shall continue the operation of same during each working day of testing and balancing.

O. Balance all water and air systems. Be sure to include:

(1) Domestic Hot Water Recirculating System.

4. FIRE PROTECTION SYSTEM

A. Test in accord with local Fire Marshall requirements and/or requirements or recommendations of NFPA Regulations.

END OF SECTION 203100

SECTION 203200 - MECHANICAL MAINTENANCE

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. MECHANICAL MAINTENANCE CONTRACT

- A. In addition to all other work indicated and specified, the Contractor shall provide the necessary skills and labor to assure the proper operation and to provide all required current preventative maintenance for all equipment and controls provided under Division 20 for a period of one year after substantial completion of the contract as defined in these specifications.
- B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided and shall take steps to immediately correct any deficiencies that may exist.
- C. The Contractor shall provide monthly inspection of all equipment and record the findings on a check list hereinafter specified.
- D. The Contractor shall provide a check list and shall post a copy of it in the main mechanical room. The check list shall be a list of each piece of equipment found in Division 20 of these specifications. The check list shall have a space for each of the next 12 months to provide a space for check-off. The Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, it has been properly lubricated, and that all necessary current and preventative maintenance has been performed as recommended by the manufacturer and by good and accepted practice. This check list shall be approved in writing by the Engineers.
- E. All equipment that requires repairing shall be immediately serviced and repaired. Since the period of maintenance runs for one year concurrently with the warranty and guarantee, all parts and labor shall be furnished at no extra cost to the Owner.
- F. Control System - Once each month, the Control Sub-Contractor shall check all controls in the building to ascertain that they are functioning as designed and installed. This shall apply to all thermostats, aquastats, humidistats, freezestats, and firestats. This portion of the work shall be performed only by the Sub-Contractor that installed the controls.
- G. Filter maintenance shall be a special part of this contract and this Contractor shall inspect all filters once every month and shall clean or replace filter as necessary.
- H. When emergency service is required beyond regular working hours to maintain the system in operation, the Contractor shall furnish such service.

- I. Failure on the part of the Contractor to comply with all or part of this section of his work, will be required to relinquish a portion of his original contract sum. In general, that cost will be determined by the cost incurred by the owners to have work accomplished which should have, by contract, been accomplished by the Contractor.

END OF SECTION 203200

SECTION 220100 - PLUMBING SPECIALTIES

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work specified in this section.
- B. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the International Plumbing Code.
- C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.
- D. Prior to final inspection, test by operation at least twice, all equipment.
- E. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from equipment and specialties and thoroughly clean same.
- F. All equipment and specialties shall be installed as recommended by the manufacturer in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.
- G. All pipes, valves, fittings, fixtures, etc. for use in potable water systems 2" and below shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. DRAINAGE SPECIALTIES

A. GENERAL

- (1) Provide all drainage specialties indicated, specified and/or required to provide complete and acceptable removal of all storm, sanitary, waste, laboratory waste, etc. from the building and into approved receptors.
- (2) Drainage specialties shall be on non-electrolytic conduction to the material to which they are connected.
- (3) Drainage specialties shall be installed in a manner so as to ensure no leakage of toxic or odorous gases or liquids and shall have traps and/or backflow preventers where required. Nor shall they allow backflow into other or existing systems.

B. CLEANOUTS - INTERIOR (CO)

- (1) In addition to cleanouts indicated, provide cleanouts in soil and waste piping and storm drainage at the following minimum locations:
 - a. At base of each stack.
 - b. At fifty (50) foot maximum intervals in horizontal lines.
 - c. At each change of direction of a horizontal line.
 - d. As required by current IPC.
 - e. As required to permit rodding of entire system. (If in doubt, contact Engineers.)
- (2) Water closets, slop sinks and other fixtures with fixed traps shall not be accepted as cleanouts.
- (3) Cleanouts and/or test tees concealed in inaccessible pipe spaces, walls and other locations shall have an eight (8) inch by eight (8) inch (minimum) access panel or cover plates shall be set flush with finished floors and walls and shall be key or screw driver operable.
- (4) Access panels for cleanouts shall be of the Zurn, 1460 series or equivalent by Josam or Watts. They may, at the Contractor's option, be Perma-Coated steel, prepared to receive finish. The Contractor shall coordinate the finish of all access panels installed in finished areas with Architect.
- (5) Cleanouts and access panels shall be sized so as to permit the entry of a full sized rodding head capable of one hundred percent circumferential coverage of the line served.
- (6) Provide a non-hardening mixture of graphite and grease on threads of all screwed cleanouts during installation.
- (7) Do not install cleanouts against walls, partitions, etc. where rodding will be difficult or impossible. Extend past the obstruction.
- (8) In finished walls, floors, etc., ensure that cleanouts are installed flush with finished surfaces and, where required, grout or otherwise finish in a neat and workmanlike manner.
- (9) Cleanouts shall be as manufactured by Zurn, Josam, Jay R. Smith, Watts, MIFAB, Ancon or equivalent, similar to the following:
 - a. Zurn, Z-1440 cleanouts or Z-1445 cleanout tee at base of exposed stack and at change in direction of exposed lines.
 - b. Zurn, Z-1440 cleanout or Z-1445-1 cleanout tee where stacks are concealed in finished walls
 - c. Zurn, ZN-1400-T cleanout with square scoriated top in finished concrete and masonry tile floors.
 - d. Zurn, ZN-1400-Tx cleanout with square recessed top for tile in vinyl and linoleum finished floors.

- e. Zurn, ZN-1400-Z cleanout with round recessed top for terrazzo floors.
- f. Zurn, Z-1400-HD cleanout with tractor cover for exterior locations. Provide concrete supporting pad crowned to shed water. Refer to drawings for pad size.
- g. Mueller, No. D-731 or D-714, Nibco, Flage or equivalent for cleanouts in copper waste with cover plates and/or access panels listed for other cleanouts.
- h. Threaded hex head type cleanouts of same materials as pipe for piping 2" and smaller.
- i. Zurn, cleanout with round top with adjustable retainer for carpet area. Install flush with carpet.

C. FLOOR DRAINS

- (1) Provide floor drains at locations indicated. Install in a neat and workmanlike manner. Coordinate locations with appropriate persons or party to ensure floor pitch to drain where required.
- (2) Install floor drains in strict accordance with manufacturer's recommendations and the IPC unless otherwise indicated.
- (3) Each floor drain located on floors above the lowest floor shall be provided complete with a three (3) foot by three (3) foot, four (4) pound sheet lead flashing and clamping collar or chlorinated polyethylene shower pan liner of 30 mil. Lead pans shall be given a heavy coat of asphaltum on bottom and sides before installation and a heavy coat on exposed surfaces (if any). After installation, provide one ply of fifteen (15) pound roofing felt beneath each pan.
- (4) Ensure by coordination with the appropriate persons or party that spaces served by a floor drain(s) has a water seal extending at least three (3) inches from the floor of the space served on all floors above the lowest level.
- (5) The floor drains shall be Zurn, Josam, Watts, Jay R. Smith, MIFAB, Sioux Chief or equivalent, similar to the following:
 - a. FD-1:
Refer to plans.

D. TRAP PRIMERS

Provide trap primers for all floor drains and open receptacle. Acceptable Trap Primer Manufacturers included Zurn, Precision Plumbing Products and Sioux Chief. Trap Primer selection shall be as follows:

- (1) Trap Primer Type-1 (TP-1)

Refer to plans.

E. CLEANOUTS (EXTERIOR) (ECO)

Provide exterior cleanouts at each location indicated and in the manner indicated.

F. ROOF DRAINS

(1) Each drain shall be provided complete with a three (3) foot by three (3) foot, four (4) pound sheet lead flashing and clamping collar. Roof drains shall be installed in strict accordance with the drain manufacturers and roofing manufacturer's instructions. Provide all accessories required for a complete installation.

(2) RD-1

Refer to plans

G. VARMINT GUARDS

Provide at each live discharge and/or culvert discharge (where culvert exceeds 30 linear feet in length) and where the line has a surface opening greater than one-half (2) square feet, a three (3) inch mesh steel varmint guard made up with frame and 3/8-inch minimum steel rods welded together and affixed tightly into the end of the open pipe.

3. WATER SUPPLY SPECIALTIES

A. GENERAL

(1) Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in a neat and workmanlike manner in accordance with the manufacturer's recommendations and the IPC.

(2) Where required by the AHJ, install code approved vacuum breakers in each water supply specialty.

B. FREEZEPROOF WALL HYDRANTS (FPWH)

(1) Provide code approved wall hydrants at each location indicated in a neat and workmanlike manner. Affix tight to walls and ensure that the feed piping is on the heated side of the building insulation blanket.

(2) Where hydrants are of handwheel type, remove handwheels and turn over to owners in an envelope labeled "Wall Hydrants" exterior upon completion of the project.

- (3) Where hydrants have key operators, turn over at least two (2) keys in an envelope labeled "Wall Hydrants" to owners upon completion of the project.
- (4) Where hydrants have lockable boxes, turn over at least two (2) keys in an envelope labeled "Wall Hydrants, Exterior" to owners upon completion of project.
- (5) Mount all wall hydrants at least twenty (20) inches above finished exterior grade. Where this is not possible or practical, contact Engineers.
- (6) Wall hydrants shall be as follows or equivalent:
 - a. Refer to plans.

C. WATER HAMMER ARRESTORS (WHA): Provide water hammer arrestors at each location indicated and/or as required to eliminate hydrostatic on the domestic water system. Provide at least one water hammer arrestor at all quick acting valve locations including:

- Automatic Clothes Washers – Type “A”
- Commercial Dishwashers – Type “B”
- Sterilizers – Type “B”
- Mop Basins (downstream of check valve) – Type “A”
- Flush valve fixtures - Type “B” (Each toilet room with 1-3 flush valve fixtures shall have its own Type “B” water hammer arrestor.)

- (1) Multiple Fixtures – Branch Line Less Than 20’ Long: The preferred location for a Zurn Shoktrol is at the end of the branch line between the last two fixtures when the branch lines do not exceed 20’ in length, from the start of the horizontal branch line to the last fixture supply on this line.
- (2) Multiple Fixtures – Branch Line More Than 20’ Long: On branch lines over 20’ in length, use two Shoktrols whose capacities total the requirement of the branch. Locate one unit between the last and next to last fixture and the other unit approximately midway between the fixtures.
- (3) Water hammer arrestors shall be Zurn, Z-1700, Shoktrol, Smith, Josam, Wade, or equivalent. Water hammer arrestors shall be stainless steel, bellows type. Field fabricated capped cylinders shall not be acceptable.
- (4) Note: Provide insulation unions where arrestors are of dissimilar material from the piping served (unless piping is non-conducting, such as ABS or PVC).

MARK	MANUFACTURER & MODEL	SIZE	P.D.I. SIZE
TYPE "A"	ZURN, Z-1700 # 100	1-11	A

TYPE "B"	ZURN, Z-1700 # 200	12-32	B
TYPE "C"	ZURN, Z-1700 # 300	33-60	C
TYPE "D"	ZURN, Z-1700 # 400	61-113	D

D. REDUCED PRESSURE BACKFLOW PREVENTERS (RPZ-1)

Watts #LF909S or equivalent reduced pressure backflow preventer. Provide with gate valves for isolation, FDA food grade strainer and air gap fitting. RPBP shall be UL listed.

4. GENERAL SPECIALTIES

A. VACUUM BREAKERS AND BACK FLOW PREVENTERS

Where required by the IPC, whether indicated or not, provide approved vacuum breakers or backflow preventers at the following locations.

- (1) Where domestic water system connects to fire protection system.
- (2) Where domestic water system connects to hydronic system.
- (3) At any hose (threaded) tap on the domestic water system.

B. ROOF FLASHINGS

All plumbing vents or other plumbing passing thru the roof shall be flashed as approved by the IPC and as recommended by the roofing manufacturer and/or Contractor.

C. GAS PRESSURE REGULATORS

Provide gas pressure regulators for all gas fired equipment that requires a lower pressure than what is delivered to the appliance. Regulators shall be installed in accordance with the requirements of NFPA 54 and/or International Fuel Gas Code, whichever is more stringent.

END OF SECTION 220100

SECTION 220200 - PLUMBING FIXTURES, FITTINGS AND TRIM

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall provide all fixtures complete with trim required and connect in a manner conforming to the State Plumbing Code.
- C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.
- D. All exposed piping or in casework below sinks, stops, traps, tailpieces, etc., shall be code approved chrome plated brass unless otherwise indicated or specified. Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws.
- E. All fittings, fixtures and trim shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, material, etc. as those specified. All faucets, shower heads, drains, levers, trim, etc. shall be constructed of metal and not plastic.
- F. Handicapped fixtures shall be mounted as recommended by the ADA.
- G. All fixtures shall be mounted as recommended by the manufacturer. Fixtures shall be rigidly mounted to walls and floors. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky flush valves, lavatories, etc. shall not be acceptable.
- H. Prior to final inspection open all faucets and allow to run for fifteen (15) minutes, then remove all faucet aerators and thoroughly clean until smooth flow is obtained.
- I. Prior to final inspection, test by operation at least twice:
 - (1) (Where applicable) adequate flow of hot and/or cold water at;
 - a. Shower Heads
 - b. All Faucets
 - c. Flush Valves and Tanks
 - d. Tub Drains
 - e. Hose Bibbs
 - f. Sill Cocks
 - g. All Other Valved Hot and/or Cold-Water Openings in the Plumbing System

(2) All toilet seats

(3) All flush tank overflows

- J. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from plumbing fixtures and thoroughly clean same.
- K. All sink and lavatory traps shall have screw in plugs in the bottom for ease of cleaning and have mechanical fittings for ease of removal.
- L. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service.
- M. Special Note for Handicap Grab Rails: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.
- N. All exposed drain pipes and domestic water piping under handicap accessible sinks and lavatories shall be insulated in accordance with ADA requirements and shall have a vinyl plastic covering over all insulation.
- O. The Contractor shall obtain a copy of the casework shop drawings and confirm sinks, faucets, gas turrets, etc., will fit in the space provided. Additionally, in ADA applications with handicap sink base cabinets, the Contractor shall limit the total distance from the bottom of the sink to the bottom of the P-trap and coordinate waste pipe rough-in height to ensure the proper installation of the handicap sink base cabinet front closure panel. The Contractor shall not order sinks until he confirms no conflicts occur and shall adjust sink sizes if required. If the Contractor orders sinks, faucets, etc., that do not fit in the casework supplied, he shall replace them at no additional cost.
- P. All lavatories, sinks, etc. shall be supplied with center rear drain outlets where necessary to avoid conflict with casework, handicapped kneeboards, etc. If the Contractor orders sinks that do not fit in the casework supplied, he shall replace them at no additional cost.
- Q. All single supply faucets shall be provided with mechanical mixing valves unless otherwise noted. Mechanical mixing valves shall have hot and cold-water inlet connections, common outlet, in-line check valves, and adjustable temperature setting. Mixing valves shall be Moen model 104424 or equal. Provide one mixing valve per single supply faucet unless otherwise noted. Contractor shall provide all required connections and set mixing valve to required temperature.
- R. All gooseneck faucets shall have rigid spouts, unless swing spouts are specified. If swing spouts are specified, the spout shall have a maximum swing of 140 degrees from side to side.
- S. All plumbing fixtures shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.
- T. All water closet handles on ADA water closets shall be located on the approach side of the fixture.

2. FIXTURES AND TRIM

Available Manufacturers: Subject to compliance with requirements of manufacturers offering plumbing fixtures and trim. Plumbing fixtures and trim, which may be incorporated in the work include, but are not limited to, the following:

A. Plumbing Fixtures - Water Closet, Lavatory, Urinal, Bathtubs, Clinical Sink and Scrub Sink

American Standard, U.S. Plumbing Products
Eljer Plumbingware Div., Wallace-Murray Corp.
Kohler Co.
Crane Plumbing
Universal-Rundle
Toto
Zurn Co.
Sloan Fixtures

B. Plumbing Trim

American Standard, U.S. Plumbing Products
Chicago Faucet Co.
Kohler Co.
Delta Co.
T&S Brass & Bronze Work Co. (Commercial)
Zurn Co.
Just Co.
Speakman Co.
Moen Commercial

C. Flush Valves

Delany Co.
Sloan Valve Co.
Zurn Co.
American Standard

D. Fixture Seats

Bemis Mfg. Co.
Church Seat Co.
Olsonite Corp., Olsonite Seats

E. Water Coolers

Elkay Mfg. Co.

Halsey Taylor Div., King-Sealey Thermos Co.
Haws Drinking Faucet Co.
Western Drinking Fountains, Div. of Sunroc Corp.
Oasis Co.
Acorn AQUA

F. Service Sinks and Mop Basins

American Standard, U.S. Plumbing Products
Eljer Plumbingware Div., Wallace-Murray Corp.
Fiat Products
Kohler Co.
Stern-Williams Co., Inc.
Florestone

G. Stainless Steel Sink

Elkay Mfg. Co.
Just Mfg. Co.
Moen, Div. of Stanadyne/Western
Sterling Co.

H. Fixture Carriers

Josam Mfg. Co.
Jay R. Smith
Tyler Pipe
Zurn Industries
Watts

I. Shower

Bradley Co.
Zurn Co.
Symmons Industries, Inc.
Chicago Faucets
Speakman Company
Powers
Acorn Co.
Moen Commercial

J. Shower Stalls

Clarion
Universal-Rundle
Aqua Bath

- Aquarius
Aqua Glass
Acryline
Lasco Bathware

- K. Canwash
 - Zurn Industries
 - Murdock
 - Woodford
 - Watts

- L. Washer/Dryer Connection Box
 - Guy Gray Co.
 - Wolverine Brass, Inc.

- M. Wash Fountain
 - Bradley Co.
 - Acorn Co.
 - Intersan
 - Willoughby

- N. Shampoo Sink
 - Belvedere

- O. Care Ware - Swingette, Swivette
 - Bradley Co.
 - Acorn Co.
 - White Hall Co.

- P. Penal Ware
 - Bradley Co.
 - Acorn Co.
 - Willoughby

- Q. Emergency Fixtures - Eyewash, Showers
 - Bradley Co.
 - Speakman Co.
 - Guardian Co.

R. P-Trap Insulation Kit (Trap Wrap)

Truebro
Brocar
Plumberex

Note: Kitchen, Lab, Science Room Fixtures, Special Equipment, Etc.

Contractor to provide final plumbing connections to all of the equipment furnished by Owner including, but not limited to: chrome supplies, stops, continuous drains, drain tailpiece, "P" traps and escutcheons.

3. FIXTURE SELECTION

A. Refer to drawings for fixture schedule.

END OF SECTION 220200

SECTION 220300 - PLUMBING EQUIPMENT

1. GENERAL

- A. All plumbing equipment shall comply with the latest provisions of the International Plumbing Code.
- B. Provide magnesium anodes for water heaters and storage tanks.

2. WATER HEATER

The heater(s) shall be Gold Series Commercial Electric Model Number DRE-52 as manufactured by A. O. Smith. Heater(s) shall be rated at 12 kW, 208 volts, 1 phase, 60 cycle AC, and listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Tank(s) shall be 50 gallon capacity. Tanks shall have 150 psi working pressure and be equipped with extruded high density anode. All internal surfaces of the heater(s) exposed to water shall be glass lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be low watt density. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Manufacturer shall supply ASME rated temperature and pressure relief valve. Fully illustrated instruction manual to be included. Meets standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1.

3. EXPANSION TANK (DOMESTIC WATER)

- A. The potable water expansion tank shall be of drawn steel construction. It shall have a Butyl diaphragm separating the air chamber from the water containing chamber. Inlet connector shall be Stainless Steel. Materials of manufacture for the diaphragm shall be FDA approved. The potable water expansion tank shall be a Watts Model PLT.

4. RECIRCULATING DOMESTIC HOT WATER PUMPS (P-DHWR)

- A. Bell and Gossett or approved equivalent stainless in-line centrifugal circulating pump with mechanical seals, drip proof motor and all required overloads, starters and disconnects. Basis of design model: ECOCIRC 20-18.

5. WATER SOFTENER SYSTEM

- A. The water softener system shall consist of polyglass mineral tank and brine tank with safety float. System shall also include a bypass control valve. System shall be rated for a system flow rate of 8 GPM.

END OF SECTION 220300

SECTION 230130- HVAC DUCT SYSTEM CLEANING

1. GENERAL

A. SCOPE OF WORK

- (1) This Section includes the requirement for cleaning of the existing supply air conveyance systems as noted on the Drawings and described below.

B. RELATED WORK SPECIFIED ELSEWHERE

- (1) Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections, apply to this Section. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the existing HVAC system supply air ductwork in accordance with these specifications.

C. SUBMITTALS

- (1) After carefully reviewing the site and requirements, submit a complete work action outline similar to item A. Scope of Work above for review by the Engineer.

D. QUALITY ASSURANCE

- (1) Contractor Qualifications: Contractor must be a certified member of the National Air Duct Cleaners Association (NADCA), and the Indoor Air Quality Association (IAQA).

E. COORDINATION

- (1) Perform cleaning at appropriate time in project as to not interfere with other trades or the progress of the work, or existing occupants working in the building.

F. APPLICABLE STANDARDS

- (1) National Air Duct Cleaners Association (NADCA) "ACR-2006, Assessment, Cleaning and Restoration of HVAC Systems, ", 2001.
- (2) National Air Duct Cleaners Association (NADCA), "Understanding Microbial, Contamination in HVAC Systems," 1996.
- (3) National Air Duct Cleaners Association (NADCA), "Introduction to HVAC System Cleaning services," 2002.
- (4) National Air Duct Cleaners Association (NADCA) Standard 05 "Requirements for the Installation of Service Openings in HVAC Systems, "1997.

- (5) Underwriters Laboratories (UL), UL Standard 181.
- (6) American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 62, Ventilation for Acceptable Indoor Air Quality.
- (7) Environmental Protection Agency (EPA), "Building Air Quality," December 1991.
- (8) Sheet Metal and Air Conditioning Contractor's National Association (SMANCA):' HVAC Duct Construction Standards — Metal and Flexible," 1985.

2. EXECUTION

A. EXAMINATION

- (1) Prior to the commencement of any cleaning work, the cleaning Contractor shall perform a visual inspection of the system to be cleaned to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. Provide video and/or photo report of before and after conditions at multiple areas.
- (2) Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

B. GENERAL CLEANING REQUIREMENTS

- (1) Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.
- (2) Particulate Collection: where the particulate collection equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the particulate collection equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with particulate collection equipment in place, including adequate filtration to contain debris removed from the HVAC system. When the particulate collection equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into any building.
- (3) Controlling Odors: Measures shall be employed to control odors and/or mists vapors during the cleaning process.
- (4) Component Cleaning: Cleaning methods shall be employed such that all components must be visibly clean as defined per NADCA applicable standards. Upon completion, all components shall be returned to those settings recorded just prior to cleaning operations.
- (5) Air-Volume Control devices: Dampers and any air-directional mechanical devices inside

the HVAC system must have their position marked beforehand so that they can be returned to their pre-cleaning position.

- (6) Service Openings: The Contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical mechanical entry, and inspection.
 - a. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
 - b. Additional openings shall be created by the Contractor as outlined on the Drawings to assist in plenum cleaning.
 - c. The Contractor shall remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.

C. SANITIZING AND CLEANING

- (1) Antimicrobial Agents and Coatings:
 - a. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 - b. Antimicrobial treatments and coatings shall be applied after the system is rendered clean.
 - c. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
 - d. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

D. HEALTH AND SAFETY

- (1) Safety Standards: Cleaning Contractor shall comply with applicable federal, state, and local requirements for protecting the safety of the Contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administrations (OSHA) shall be followed when working in accordance with this specification.
- (2) Occupant Safety: No processes of materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

END OF SECTION 230130

SECTION 230200 - HVAC EQUIPMENT AND HYDRONIC SPECIALTIES

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.
- C. Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer's Checklist.
- D. Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include air handling units, boilers, chillers, cooling towers, VFDs, etc.
- E. All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and/or International Energy Conservation Code 2012, whichever is more stringent.
- F. Installation of all heating, ventilating and air conditioning systems shall be performed by a master HVAC contractor licensed in the state the work will be performed.
- G. Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:
 - (1) Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any. The Contractor shall provide all controls with equipment unless specifically listed otherwise.
 - (2) Review the section of these specifications entitle: SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.
 - (3) Ensure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.
 - (4) Determine from the Bid Documents the date of completion of this project and ensure that equipment delivery schedules can be met so as to allow this completion date to be met.

- (5) Where manufacturers' temperature controls are specified, they shall be in full compliance with International Mechanical Code Section 606 including automatic smoke shut down provisions.
- (6) Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, including pumps, VFDS, boilers, chillers, cooling towers, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer.
- (7) Provide training to the Owner by a factory representative for each type of equipment. Training shall be a minimum of eight (8) hours on site and the Engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be videotaped.
- (8) Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.
- (9) Requirements for motors controlled by variable frequency drives:
 - a. All motors shall be inverter duty rated.
 - b. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.
 - c. Motors greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer's instructions. Additionally, provide insulated bearing journals to further reduce risk of current dissipation through bearings. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.
- (10) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.
- (11) Provide low ambient and all required controls and accessories on all HVAC equipment to ensure they can provide cooling during the winter season.
- (12) All outdoor HVAC equipment shall be provided with hail guards.
- (13) Provide a complete air tight enclosure with opening door that seals air tight for all filters on air moving equipment.

- (14) All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

2. EQUIPMENT

A. VENTILATING FANS

- (1) Ventilating fans shall be of the type, capacity, size, etc. here-in-after scheduled. Catalog numbers are listed as design criteria only. Alternate selections will be accepted provided quality, function, etc. are equivalent. All fans shall be UL listed, complete with all required disconnects and starters and shall be AMCA rated and certified. Model numbers listed are Greenheck, acceptable alternates are Captive Air, Loren-Cook, or approved alternate. The Architect shall select the color for all exposed fans.

(2) Selection

Refer to the schedule on the plans.

B. COMBINATION VARIABLE FREQUENCY DRIVE / DISCONNECT (VFD) FOR MOTORS 50 HP AND LESS

(1) Manufacturers

- a. Danfoss Graham VLT 6000 Series, Reliance, Yaskawa, Emerson, ABB, or approved equal.

(2) General

- a. Furnish complete variable frequency VFDs as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA enclosure of type according to the installation and operating conditions at the job site. The VFD's UL listing shall allow mounting in plenum or other air handling compartments. If a NEMA 12 enclosure is required for the plenum rating, the manufacturer must supply a NEMA 12 rated VFD.
- b. The VFD shall have integral disconnecting means to disconnect power to device in accordance with NEC.
- c. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
- d. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or

without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

- e. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- f. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. When these VFDs are to be located in Canada, CSA or C-UL certifications shall apply. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.
- g. The VFD shall have a dual 5% DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the drive from power line transients. The reactor shall be non-saturating (linear) to provide full harmonic filtering throughout the entire load range. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- h. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- i. The VFD shall be able to provide full torque at any selected frequency from 29 Hz to base speed to allow driving direct drive fans without derating.
- j. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- k. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- l. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- m. Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

- n. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- o. VFD supplier shall coordinate with motor supplier to ensure that all motors 20 horsepower and greater are provided with grounding bushings.

(3) Protective Features

- a. A minimum of Class 20 ² I t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- b. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
- c. Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230-volt units, 313 V AC for 460-volt units, and 394 volts for 600 volts units.
- d. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
- e. VFD package shall include semi-conductor rated input fuses to protect power components.
- f. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the VFD manufacturer must ensure that inverter rated motors are supplied.
- g. VFD shall include a “signal loss detection” circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
- h. VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
- i. VFD shall catch a rotating motor operating forward or reverse up to full speed.
- j. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

- k. VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
- l. VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230-volt units, 539 V AC on 460-volt units, and 690 volts on 600-volt units.

(4) Interface Features

- a. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
- b. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
- c. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
- d. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
- e. The keypads for all sizes of VFDs shall be identical and interchangeable.
- f. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
- g. Display shall be programmable to display in 9 languages including English, Spanish and French.
- h. The display shall have four lines, with a minimum of 20 characters on three lines and a minimum of eight large characters on one line.
- i. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- j. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
- k. As a minimum, the following points shall be controlled and/or accessible:
 - 1) VFD Start/Stop
 - 2) Speed reference
 - 3) Fault diagnostics
 - 4) Meter points
 - (a) Motor power in HP
 - (b) Motor power in kW
 - (c) Motor kW-hr

- (d) Motor current
 - (e) Motor voltage
 - (f) Hours run
 - (g) Feedback signal #1
 - (h) Feedback signal #2
 - (i) DC link voltage
 - (j) Thermal load on motor
 - (k) Thermal load on VFD
 - (l) Heatsink temperature
- l. Four additional Form C 230-volt programmable relays shall be available for factory or field installation within the VFD.
 - m. Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
 - n. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
 - o. Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
 - p. Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.
 - q. The sleep mode shall be functional in both follower mode and PID mode.
 - r. Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
 - s. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kW-hr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
 - t. The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (°F) for a cooling tower application.
 - u. VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.

- v. If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- w. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- x. The VFD shall store in memory the last 10 faults and related operational data.
- y. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- z. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
 - aa. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltages (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
 - bb. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.
 - cc. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.
 - dd. On motors connected to variable frequency drives, 20hp or greater in size. Provide grounding bushings to prevent arcing.

(5) Interface with Building Automation System/Direct Digital Control System

- a. VFD manufacturer shall provide an interface to the BAS/DDC system. Manufacturer shall coordinate as required with the Controls Contractor. Provide Bacnet, Lonworks, FLN, Modbus, or any other interface required for a complete and operational system.
- b. Provide mode of operation to BAS/DDC system (hand, off, auto, etc.). BAS/DDC graphic shall highlight or produce pop-up graphic when VFD is in hand or off. Also, provide all points to BAS/DDC identified in section (4).K of this Specification.

(6) Adjustments

- a. VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

- b. Sixteen preset speeds shall be provided.
- c. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
- d. Four current limit settings shall be provided.
- e. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: under voltage, overvoltage, current limit and inverter overload.
- f. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- g. An automatic "on delay" may be selected from 0 to 120 seconds.

(7) Service Conditions

- a. Ambient temperature, -10 to 40°C (14 to 104°F), without derating.
- b. 0 to 95% relative humidity, non-condensing.
- c. Elevation to 3,300 feet without derating.
- d. AC line voltage variation, -10 to +10% of nominal with full output.
- e. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

(8) Quality Assurance

- a. To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
- b. All optional features shall be functionally tested at the factory for proper operation.

(9) Submittals

- a. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.

The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

- a. Harmonic filtering. The seller shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

(10)Start-Up Service

- a. The manufacturer shall provide on-site start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Provide start-up report to Engineer.

(11)Warranty

- a. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

(12)Examination

- a. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.
- b. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3. FACTORY START-UP REPORTS

- A. Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, including pumps, VFD's, boilers, chillers, cooling towers, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer. The Mechanical Contractor and the Controls Contractor shall have a representative on site to correct all deficiencies noted by the

factory representative. For each deficiency noted, documentation of corrective action taken shall be submitted to Engineer.

4. HVAC SYSTEM START-UP PROCEDURE

A. GENERAL

- (1) The goal of this procedure is for a few units to run as much as possible with the coils as cold as possible to "wring out" the water and allow it to drain away in the condensate drain pans. Allowing all units to cycle on and off, running for short periods of time, does not dehumidify the air in the building. Starting the system without following the steps outlined will raise the relative humidity in the building and most likely cause condensation on some of the building surfaces and HVAC system that the Contractor will be responsible to correct.
- (2) The high humidity and condensation occurs in buildings at start up primarily because the building is only partly occupied (or not occupied) when the HVAC system is started. Most people believe that the answer to this problem is to turn the thermostats down very low. The assumption is that cold air will not hold moisture. That is not true. What happens is that the thermostats are quickly satisfied thermally because there is very little cooling load on the building and the cooling equipment. The terminal units then only have to run for a very short period of time to keep the thermostats satisfied and the relative humidity of the air is in fact raising. The goal is to cause the moist air to pass over coils which are cooling it and drying it without allowing more moist air to be introduced into the building.
- (3) To reduce the always present high humidity start-up problem, we have devised this start-up procedure that will minimize the adverse effects of the start-up. As the building sits at start-up, all of the walls, floor, and ceilings are saturated with moisture from the air and also moisture is being released from the drying paint and curing concrete and mortar.
- (4) The following procedure will slowly bring down the temperature and humidity in the lightly loaded building. It will also allow the HVAC equipment to more closely match the actual building load without students and equipment in use.

To reach these goals we require the following:

- (1) Set 1/3 of the units (approximately every third unit) on 74°F (no lower). Set the other thermostats for a cooling setpoint of 90°F so the units will not cool. Override the controls so that the fans in all units will circulate air.
- (2) Leave all of the interior doors open to allow the air to mix throughout the building.
- (3) Close all exterior windows and doors.
- (4) Turn off all exhaust fans and outside air units. Outside air unit exhaust and outside air dampers shall be closed.

(5) Leave all of the lights on in the building to provide a cooling load.

(6) Provide portable electric heaters or dehumidifiers in any room that shows signs of condensation.

END OF SECTION 230200

SECTION 230300 - CONDENSATE DRAINAGE SYSTEM (FOR COOLING EQUIPMENT)

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this section of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall provide a complete condensate drainage system to carry all condensate discharge from all cooling equipment from the building. Condensate system shall be installed in accordance with IMC. Provide condensate overflow switch for all condensate producing equipment.
- C. Pipe installation and fabrication shall be in accordance with the section of these specifications entitled PIPE, PIPE FITTINGS AND PIPE SUPPORT and as hereinafter specified.
- D. All piping shall be installed concealed, unless specifically noted otherwise and shall be installed under slabs or underground only when specifically indicated.
- E. Lines installed in ceiling spaces shall be held at the maximum possible elevation and shall be coordinated with all other trades to avoid conflicts.
- F. Condensate drain lines shall be pitched 1/4 inch per foot and installed with cleanout plugs at each change in direction and/or at thirty (30) foot intervals. Where this minimum pitch cannot be attained, contact Engineers.
- G. Horizontal runs of condensate drain lines shall be supported at six (6) foot intervals maximum, or more frequently where required to prevent sags and low spots.
- H. Lengths of horizontal lines shall be held at a minimum due to potential lint collection.
- I. Provide condensate traps in accordance with the manufacturer's recommendations.

2. MATERIAL

- A. Refer to Section of these Specifications entitled: PIPE, PIPE FITTINGS AND SUPPORT.

3. INSULATION

- A. Refer to Section of these Specifications entitled: INSULATION - MECHANICAL.

END OF SECTION 230300

SECTION 231100 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

1. REGISTERS, GRILLES AND DIFFUSERS

A. GENERAL

Alternate register, grille, & diffuser selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price, Titus, Metalaire, Nailor, Carnes, Anemostat, Kruegar, and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. If Architect elects not to select color, all colors shall be off-white. Factory color samples shall be submitted with shop drawings.

B. SELECTION

Refer to the Selections Scheduled on the Drawings.

END OF SECTION 231100

SECTION 231200 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.
- C. Ductwork shall be constructed and installed per the latest edition of the International Mechanical Code.
- D. Ductwork shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4" above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on all return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. Do not install the ductwork if the building is not "dried-in". If this is required, the open ends of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

Prior to purchase and fabrication of ductwork (shop fabricated or manufactured), the Contractor shall coordinate installations with new and existing conditions. Notify the Engineer if there are any discrepancies for resolution.

- E. Provide a SMACNA duct cleanliness level "C" per the latest SMACNA standards. [Refer to LEED / Healthcare Requirements]
- F. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.

- G. Wall Penetrations: Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching, and repairing section of the specifications for additional requirements.
- H. Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.
- I. Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated AutoCAD drawings of the complete system to be furnished. Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

2. LOW PRESSURE DUCTWORK

A. General (Low Pressure)

- (1) Double turning vanes shall be installed in all square turns and in any other locations indicated.
- (2) Provide a “high efficiency” type take-off with round damper (Flexmaster STOD-B03 or approved equal) for all round duct branches from a rectangular main to a GRD. Refer to the detail on the drawings for all installation requirements.
- (3) Cross-break all ducts where any duct section dimension or length is 18" or larger.
- (4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.
- (5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.
- (6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc. Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.
- (7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. Duct supports shall not exceed 12 ft intervals. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from purlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.

- (8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.
- (9) All ductwork connections, fittings, joints, etc., including longitudinal and transverse joints, seams and connections shall be sealed. Seal with medium pressure, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, nonflammable, and rated to 15" wg. Apply per manufacturer's recommendations. Contractors shall ensure no exposed sharp edges or burrs on ductwork.
- (10) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.
- (11) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.
- (12) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.
- (13) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.
- (14) All fans and other vibrating equipment shall be suspended by independent vibration isolators.
- (15) The interior surface of the ductwork connecting to return/exhaust air grilles shall be painted flat black. The ductwork shall be painted a minimum of 24" starting from the grille.

B. Materials (Low Pressure Single Wall)

- (1) Ductwork, plenums and other appurtenances shall be constructed of the following:
 - a. Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating or aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14. Utilize Aluminum in MRI Scan Rooms or NMR Room applications.
 - b. Exposed ductwork in finished spaces requiring insulation such as gymnasiums, etc., shall be dual wall ductwork.

- (2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the latest SMACNA 2" W.G. Standard or the below table, whichever is more stringent. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum:

ROUND DUCT		RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 12	26	UP TO 12	26
12 TO 18	24	13 TO 30	24
19 TO 28	22	31 TO 54	22
29 TO 36	20	55 TO 84	20
37 TO 52	18	85 AND ABOVE	18

C. Materials (Low Pressure Double Wall Ductwork)

- (1) Install Double Wall Ductwork in the following areas:
 - a. At all locations indicated on drawings.
- (2) Furnish and install where indicated double wall duct. The double wall duct shall be Eastern Sheet Metal, United McGill, Semco or approved equivalent. The duct shall have an inner shell, a 1-inch layer of fiberglass insulation and an outer pressure shell.
- (3) Ductwork outer shell shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Any ductwork exposed to view shall be constructed of G90 galvanized steel, 20 gauge, and shall be supported as required with aircraft cables and self-tightening locks. Ductwork shall be constructed as specified in LOW PRESSURE DUCTWORK.
- (4) Inner shell for spiral pipe shall be a perforated inner liner. The inner liner shall have 3/32" perforation with an overall open area of 23%.
- (5) Inner shell for fittings shall be galvanized steel. All fittings shall be manufactured by the same manufacturer as the spiral pipe. Fittings shall be constructed a minimum of 22 Ga.
- (6) The fiberglass liner shall have a maximum thermal conductivity (k) factor of 0.27 btu per hour per square foot per degree Fahrenheit per inch thickness at 75-degree F ambient temperature.
- (7) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which

shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

- (8) All grille and register taps shall be factory manifolded. Field installed taps will not be allowed. Manifolded taps may be tack welded and caulked for appearance. Only taps for grilles and registers may be provided this way. All other fittings shall be full body welded.

D. Miscellaneous (Low Pressure)

(1) Un-insulated Flexible ductwork (Use Only Where Indicated)

- a. Un-insulated flexible ductwork shall be corrugated aluminum. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.
- b. Flexible ductwork installed in a return or exhaust or other negative static pressure application shall be rated for installation in negative pressure systems.

(2) Insulated Flexible Duct (Use Only Where Indicated)

- a. Owens/Corning or equivalent, 1 ½" inch thick fiberglass insulation; flexible liner; with aluminum pigment vinyl vapor barrier facing. Insulated flexible duct shall meet Fire Hazards Standards of NFPA 90A and IMC, flame spread not to exceed 25, smoke develop and fuel contributed not to exceed 50 when tested in accordance with ASTM-E84. Minimum R-value of 6.0, tested in accordance with ASTM C177.71. Flexible duct may be used only for runouts and no sections shall be more than five feet in length.
- b. When flexible duct is located in areas where it will be visible because the ceiling allows views to the ductwork above, the flexible duct shall be black. The black color shall be factory coloring and not field applied.
- c. Flexible duct shall not be used in areas where there is no ceiling.
- d. Flexible ductwork installed in a return or exhaust or other negative static pressure application shall be rated for installation in negative pressure systems

- (3) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low pressure ducts secured with snap lock.

- (4) Turning Vanes: Duro-Dyne or equivalent fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

- (5) Splitter Damper: Splitter damper shall be constructed of 16-gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint

bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

- (6) Access Doors; In Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 1" thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.) and downstream side of VAV boxes and CAV boxes.
- (7) Architectural Access Doors in Ceilings or Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24"x24" in size and constructed with 16 gauge galvanized steel for door and frame. In finished areas, provide with primed steel with 1" border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1" border. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer's standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.
- (8) Security Architectural Access Doors in Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees SSAP Panel, Cesco, Milcor or equal. Panels shall be 24"x24" in size and constructed with 12-gauge steel for door and frame. In finished areas, provide with primed steel with 1" border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1" border. Door shall include key-operated cylinder dead bolt lock (coordinate cylinders and keys with Owner to match facility standards) and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors and straps. For fire rated units, provide manufacturer's standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.
- (9) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorf rectangular volume dampers. Frames shall be 4" x 1" x 16-gauge galvanized steel. Blades shall be opposed blade 16-gauge galvanized steel with triple crimped blades on 6" centers. Linkage shall be concealed in jamb. Bearings shall be 1/2" nylon. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

- (10) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorff round volume dampers. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20-gauge steel, 6" long. Damper blades shall be 20-gauge galvanized steel. Axle shall be 3/8"x6" square plated steel. Bearing shall be 3/8" nylon. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.
- (11) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3-hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16-gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. **All fire dampers shall be dynamic. Static fire dampers are not allowed.** Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2-hour rating or Ruskin Type DIBD 23 for a 3-hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.
- (12) Motor Driven Smoke Dampers – Air Foil Blade: Provide Ruskin SD60 smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more stringent. Other acceptable manufacturers are Air Balance or Pottorff. All smoke dampers shall be three inches larger than HVAC duct in each direction. Frame shall be a minimum of 18-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions) with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Actuator to be mounted outside of air stream. The pressure drop shall not be greater than .16" wg @ 2500 FPM when tested by an independent laboratory. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

(13) Motor Driven Fire/Smoke Dampers – Air Foil Blade: Fire damper shall be constructed and tested in accordance with UL Safety Standard 555. The damper shall be Ruskin FSD60. Other acceptable manufacturers are Air Balance or Pottorff. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Frame is to be a minimum of 16-gauge galvanized steel, rollformed into a structural hat shape channel. Frame seals shall consist of flexible, compression type stainless steel. The damper and actuator electric shall be rated to an elevated temperature or 250 degrees F or 350 degrees F. In addition, the damper must be factory supplied with actuator and sleeve to comply with the requirements of UL 555S. These dampers shall have been constructed and tested in compliance with U.L. Standard 555 and U.L. Standard 555S, current editions. The pressure drop shall not be greater than .25 in.wg. At 2500 fpm when tested by an independent laboratory. Each damper shall bear an approved U.L. label identifying its classification as a Dynamic Rated Fire Damper (Static Rated dampers are not acceptable), and shall further be classified by U.L. as a Leakage Rated Damper for use in Smoke Control Systems. Each damper shall have a 1-1/2-hour fire protection rating, 212EF U.L. Listed fusible link and a leakage class I. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84" wide and 18 gauge above 84" wide. Actuator to be mounted outside of air stream. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

(14) Motor Driven Control Dampers – Provide Ruskin Model CD50 air foil damper as shown on the plans. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, 6 inches wide. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Blade seals shall be equal to Ruskinprene. Leakage Rating shall be Pressure/Class 1.

3. MEDIUM PRESSURE DUCTWORK

A. General (Medium Pressure)

- (1) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with high velocity, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, non-flammable, and rated to 15" wg. Apply per manufacturer's recommendations.
- (2) Ductwork shall be installed per SMACNA Medium or High-Pressure Manual, whichever is applicable. (Latest Edition shall apply.)
- (3) All hanger straps shall be 18 ga. minimum with reinforcement angles installed in strict accordance with SMACNA. Flat oval ducts shall be installed with 2"x2"x1/4" angles on top and bottom ducts 18" wide and larger. Use 1"x1"x3/16" angles on ducts under 18" wide.

- (4) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA or the duct manufacturer, and/or as indicated. Test openings shall be placed at the discharge of all air handling units and at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.
- (5) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panels at each fire damper located and sized so as to allow hand reset of each fire damper. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. Where access doors are installed in insulated ductwork, the access door shall be the insulated type.

B. Materials (Medium Pressure Single Wall)

- (1) All round, rectangular, and oval medium pressure ductwork for systems above 1.5" W.G. shall be Eastern Sheet Metal, United McGill or Semco or equal with construction as required by the latest SMACNA Standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section).
- (2) Any ductwork exposed to view shall be double wall and constructed of galvanized steel. Galvanized metal shall be prepped and clean prior to painting. Coordinate with General Contractor.

Ductwork shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Ductwork shall be constructed of materials of the minimum weights or gauges as required by the latest SMACNA Standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section) or the below table. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum:

ROUND DUCT (or Equivalent Diameter for Flat Oval)		RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 14	26	UP TO 12	26
15 TO 26	24	13 TO 30	24
27 TO 36	22	31 TO 54	22
37 TO 50	20	55 TO 84	20
52 TO 60	18	85 AND ABOVE	18

- (3) All medium pressure duct fittings shall be fabricated by the same manufacturer as the spiral pipe. Contractor or field fabricated fittings shall not be accepted. Duct fittings shall be constructed per the latest SMACNA standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section) with continuous welds. Take-off fittings shall be combination type tees (Eastern Sheet Metal Model "CB" or equal). Straight or angle tees are not acceptable. Fittings shall be constructed of the following minimum gauges:

ROUND DUCT (or Equivalent Diameter for Flat Oval)		RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 50	20	UP TO 36	20
51 TO 60	18	37 TO 60	18
61 TO 84	16	61 AND ABOVE	16

- (4) All single wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange on all ductwork greater than 24 inches in size.

C. Materials (Medium pressure Double Wall)

- (1) Furnish and install where indicated by drawings or specifications medium pressure double wall duct. The double wall duct shall be United McGill Acoustic K27, SEMCO, Dixie or approved equivalent. The duct shall have a **[perforated inner liner. The inner liner shall have 3/32" perforation with an overall open area of 23%.] [solid galvanized steel inner liner]**, an intermediate layer of fiberglass insulation minimum 1" thick and an outer pressure shell. Duct shall be of spiral lock seam construction fabricated from galvanized steel meeting ASTM-A527 standard. The duct insulation shall have minimum R-value of 6.0. Medium pressure double wall fittings shall have the same construction features as the double wall duct. Duct shall be constructed of G90 Galvanized steel. Outer shell of ductwork shall be constructed of the minimum gauges specified above for single wall medium pressure ductwork.
- (2) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

D. Miscellaneous (Medium pressure)

- (1) Flexible Connectors: Duro-Dyne, Ventfabrics, U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A or IMC, whichever is more stringent; neoprene coated glass fabric; 30 oz.

for medium pressure ducts secured with bolted angles. Provide flexible connectors at inlet and outlet of air handling equipment to accommodate a minimum of three times the operating pressure of the system.

- (2) Architectural Access Doors In Ceilings or Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24"x24" in size and constructed with 16 gauge galvanized steel for door and frame. In finished areas, provide with primed steel with 1" border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1" border. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer's standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.
- (3) Security Architectural Access Doors in Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees SSAP Panel, Cesco, Milcor or equal. Panels shall be 24"x24" in size and constructed with 12-gauge steel for door and frame. In finished areas, provide with primed steel with 1" border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1" border. Door shall include key-operated cylinder dead bolt lock (coordinate cylinders and keys with Owner to match facility standards) and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors and straps. For fire rated units, provide manufacturer's standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.
- (4) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3-hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16-gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. **All fire dampers shall be dynamic. Static fire dampers are not allowed.** Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2-hour rating or Ruskin Type DIBD 23 for a 3-hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.
- (5) Motor Driven Smoke Dampers – Air Foil Blade: Provide Ruskin SD60 smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more

stringent. Other acceptable manufacturers are Air Balance or Pottorff. Frame shall be a minimum of 18-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions) with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Actuator to be mounted outside of air stream. The pressure drop shall not be greater than .16" wg @ 2500 FPM when tested by an independent laboratory. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

- (6) Motor Driven Fire/Smoke Dampers – Air Foil Blade: Fire damper shall be constructed and tested in accordance with UL Safety Standard 555. The damper shall be Ruskin FSD60. Other acceptable manufacturers are Air Balance or Pottorff. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Frame is to be a minimum of 16-gauge galvanized steel, rollformed into a structural hat shape channel. Frame seals shall consist of flexible, compression type stainless steel. The damper and actuator electric shall be rated to an elevated temperature or 250 degrees F or 350 degrees F. In addition, the damper must be factory supplied with actuator and sleeve to comply with the requirements of UL 555S. These dampers shall have been constructed and tested in compliance with U.L. Standard 555 and U.L. Standard 555S, current editions. The pressure drop shall not be greater than .25 in.wg. At 2500 fpm when tested by an independent laboratory. Each damper shall bear an approved U.L. label identifying its classification as a Dynamic Rated Fire Damper (Static Rated dampers are not acceptable), and shall further be classified by U.L. as a Leakage Rated Damper for use in Smoke Control Systems. Each damper shall have a 1-1/2-hour fire protection rating, 212EF U.L. Listed fusible link and a leakage class I. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84" wide and 18 gauge above 84" wide. Actuator to be mounted outside of air stream. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements
- (7) Motor Driven Control Dampers – Provide Ruskin Model CD60 air foil damper as shown on the plans. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, 6 inches

wide. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Blade seals shall be equal to Ruskinprene. Leakage Rating shall be Pressure/Class 1.

(8) Access Doors; In Rectangular Medium Pressure Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 1" thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position.

(9) Access Doors; In Round or Oval Medium Pressure Ductwork: All access doors in round or oval medium pressure ductwork shall be screw and gasketed type. Screws shall be maximum 4 inches on centers. Access door sizes shall be as follows:

DUCT DIAMETER	OPENING SIZE
3-4 inches	4" x 10"
5-6 inches	6" x 10"
7-24 inches	10" x 16"
26-36 inches	16" x 16"
Over 36 inches	16" x 22"

4. DRYER VENT

- A. All dryer ducting shall be a minimum of 4" in diameter. Refer to the drawings for exact duct sizing.
- B. Dryer vent ductwork shall be rigid metal 20-gauge aluminum duct. Duct joints shall be installed so that the male end of the duct points in the direction of the airflow. Joints shall be secured with metal tape (not duct tape). Do not use rivets or screws in the joints or anywhere else in the duct as these will incur lint collection
- C. Length of concealed rigid metal ducting shall not exceed the allowable length of 35 feet. Deduct 5 feet from the allowable length for every 4" 90-degree elbow and 4" 2.5 feet for every 45-degree fitting. lengths may vary per local codes and dryer manufacturer's recommendations. Install per 2012 IMC Section 504 Clothes Dryer Exhaust. Provide a complete, working in-line booster fan system, including power, if the maximum allowable duct length is exceeded.
- D. Flexible transition hose connection at the dryer shall be the aluminum flexible duct type. Do not use the plastic or vinyl.
- E. Termination of dryer venting shall be to the exterior with a proper hood or roof jack equipped with a backdraft damper. Hood/jack shall be painted with suitable exterior grade paint and color per the Owner's direction. Small orifice metal screening shall not be part of the hood or roof jack as this will trap lint and block the opening. The hood opening shall point down and maintain a

minimum of 12 inches of clearance between the bottom of the hood and the ground or other obstruction.

5. DUCT SCHEDULE

A. Supply Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units:

- a. Pressure Class: Positive **2**-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
- b. Minimum SMACNA Seal Class: **A**.
- c. SMACNA Leakage Class for Rectangular: **24**.
- d. SMACNA Leakage Class for Round and Flat Oval: **12**.

(2) Ducts Connected to Variable-Air Volume Air-Handling Units RTU-1:

- a. Pressure Class: Positive **4**-inch wg Refer to medium pressure standards as outlined in section 3 of this spec.
- b. Minimum SMACNA Seal Class: **A**.
- c. SMACNA Leakage Class for Rectangular: **6**.
- d. SMACNA Leakage Class for Round and Flat Oval: **3**.

B. Return Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units:

- a. Pressure Class: Negative 2-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
- b. Minimum SMACNA Seal Class: **A**.
- c. SMACNA Leakage Class for Rectangular: **24**.
- d. SMACNA Leakage Class for Round and Flat Oval: **12**.

(2) Ducts Connected to Air-Handling Units RTU-1:

- a. Pressure Class: Negative **2**-inch wg Refer to **Low Pressure requirements as outlined in section 2 of this spec.**
- b. Minimum SMACNA Seal Class: **A**.
- c. SMACNA Leakage Class for Rectangular: **24**.
- d. SMACNA Leakage Class for Round and Flat Oval: **12**.

C. Exhaust/Relief Ducts:

(1) Ducts Connected to Exhaust Fans EF-1, EF-2, EF-3, EF-4:

- a. Pressure Class: Negative **2**-inch wg Refer to **Low Pressure requirements as outlined in section 2 of this spec.**

- b. Minimum SMACNA Seal Class: **A**.
- c. SMACNA Leakage Class for Rectangular: **24**.
- d. SMACNA Leakage Class for Round and Flat Oval: **12**.

12. Air Leakage Testing of the Ductwork Systems

- A. It is the intent of this section to ensure the ductwork installed has minimal air leakage.
- B. Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test & Balance specifications.
- C. It is the intent to test all ductwork. The duct systems which will require testing are as follows:
(Note to Designer to edit.)
 - (1) All supply air duct systems
 - (2) All exhaust air duct systems.
- D. Do not insulate the supply air systems prior to testing.
- E. The maximum allowable air leakage rate for each system tested must conform to SMACNA required leakage class rating as specified in section 11, DUCT SCHEDULE, of this spec.
- F. The entire supply air ductwork system shall be tested with some exceptions. On VAV systems, the medium pressure ductwork upstream of the VAV boxes shall only be tested. Cap the duct at the inlet to the VAV box.
- G. All return and exhaust air sheet metal ductwork associated with the system shall be tested. Flexible ductwork shall not be tested. Cap the main duct prior to the central equipment fan connection. Also cap the branch ducts which serve the diffusers, after the round branch air volume with sheet metal caps. Seal caps well to damper to avoid air loss at this location. This air loss, from the caps, is included in the noted leakage rate.
- H. The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following:
 - (1) All ductwork as described in above paragraphs.
 - (2) Access doors
 - (3) Volume dampers
 - (4) Relief air doors
 - (5) Smoke dampers

- (6) Fire dampers
- (7) Fire smoke dampers
- (8) End caps used to seal ducts
- I. If any duct system fails a test, the contractor shall reseal the system. It shall then be retested until the duct system meets the leakage allowable at no additional cost to the owner.
- J. Carefully select the ductwork construction requirements and the type of duct sealant to be used as required to meet the leakage allowances. The sheet metal duct pressure classification is a minimum only. The contractor shall select the appropriate sheet metal pressure classification, duct sealant class and duct sealant materials to meet the project air leakage allowances.
- K. Whenever the systems are being leak tested by the Test & Balance Contractor, a representative from the Mechanical Contractor shall be present to assist.

END OF SECTION 231200

SECTION 237219 – FIXED PLATE AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

1. GENERAL

A. Scope

1. Mechanical HVAC ventilation equipment shall contain a fixed plate type energy recovery system, preinstalled and tested by the manufacturer. Energy Wall™ is the basis of design.
2. Furnish owner’s manuals covering installation, maintenance, and operation.
3. Manufacturer shall warrant the energy recovery system to be free from defects in materials and workmanship for a period of 5 years after installation.

2. PRODUCT

A. Technology

1. The energy recovery system shall be based on a high efficiency fixed plate type energy recovery core with dynamic heat and moisture transfer.

B. Sustainability

1. All materials used in the energy recovery cores shall be natural and 100% recyclable. Use of exotic materials, chemicals, or rare earth elements is unacceptable.
2. The energy recovery cores must be constructed in a sustainable way, producing no hazardous effluent or unrecyclable waste.

C. Energy Recovery Cores

1. The energy recovery cores shall be constructed using an advanced energy transfer membrane capable of transferring both heat and moisture between air streams with at least 70% total efficiency when installed and operated according to the manufacturer’s recommendations.
2. The energy transfer membrane shall be made of a specially formulated paper, processed to form a semi-permeable membrane that creates a positive barrier between air streams, while facilitating the transfer of heat and moisture across the membrane.
3. The energy recovery cores shall be made of an energy transfer membrane that is machine folded, with layers separated by a machine folded corrugated net poly-spacer that provides the proper support and separation to the membrane layers, while producing sufficient air turbulence to increase energy transfer efficiency and prevent particulate buildup.
4. The energy recovery core’s membrane layers shall be ultrasonically bonded, without the use of chemicals, tapes or adhesives, to form clear air passages. The energy transfer membrane shall be impregnated with Lithium Chloride to actively facilitate the transfer of moisture between air streams and provide microbicide effect.
5. The energy transfer membrane shall act as a natural microbicide, actively killing up to 95% of microbes on contact and preventing cross-contamination between air streams. The microbicide action shall be documented by an appropriate third party testing laboratory. Microbial growth prevention treatments are not sufficient.

6. The energy transfer cores shall be capable of operating from 0° to 140°F, and will be frost-proof down to -40°F, and shall survive temperatures from -40°F to +150°F without damage.
7. The energy recovery cores shall be innumerable washable and rechargeable in salt water without any loss of performance.
8. The housing of the energy recovery cores shall be constructed of a suitable material capable of protecting the energy transfer core and preventing corrosion.

D. Energy Recovery System

1. The energy recovery system shall be constructed of corrosion proof materials, with double wall construction.
2. The energy recovery system shall be capable of field assembly using hand-transportable modules carried or hand-trucked to the installation site. Rooftop installation shall not require a rig or crane.
3. The energy recovery system shall be capable of any orientation to allow supply and return duct connections to face horizontal, downward, or upward.
4. The energy recovery system shall support the connection of multiple modules with a single connection for each airstream.
5. The energy recovery system shall support the connection of multiple modules with a single connection for controls and high voltage power.
6. The energy recovery system shall consist of single or multiple fixed plate energy recovery cores designed for counter-flow operation within each core. Cross-flow cores are less efficient and are therefore unacceptable.
7. The energy recovery system shall have no moving parts or active seals required for operation, other than bypass dampers.
8. The energy recovery system shall be capable of minimum total efficiencies of 70% when installed and operated in accordance with manufacturer's guidelines and recommendations.
9. The energy recovery media shall demonstrate fire and smoke spread ratings matching UL 900 criteria.

3. EXECUTION

A. General

1. The energy recovery system shall be installed in accordance with the manufacturer's recommendations and applicable published documents.
2. Commissioning of the system shall be by a qualified, factory trained representative or qualified, licensed contractor, and shall include a training session for owner's maintenance personnel if requested.
3. Energy recovery system shall be Energy Wall™, as manufactured by:

Energy Wall, LLC
1102 New Holland Ave. Lancaster,

PA 17601
www.EnergyWall.com

SECTION 238129 – VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

1. GENERAL

A. SYSTEM DESCRIPTION R2-SERIES (SIMULTANEOUS HEAT/COOL)

1. Per the equipment schedule, the variable capacity, heat pump heat recovery air conditioning system basis of design is Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system(s).
2. **Acceptable alternative manufacturers**, assuming compliance with these equipment specifications, are **Daikin**, Panasonic, and Hitachi. Contractor bidding an alternate manufacturer does so with full knowledge that that manufactures product may not be acceptable or approved and that contractor is responsible for all specified items and intents of this document without further compensation.
3. Simultaneous heating/cooling (heat recovery) systems shall consist of an outdoor unit, BC (Branch Circuit) Controller (or comparable branch devices), multiple indoor units, and an integral DDC (Direct Digital Controls) system. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes.
4. No additional branch circuit controllers (or comparable branch devices) than shown on the drawings/schedule may be connected to any one outdoor unit. Contractors proposing alternate systems requiring more branch devices than those included as the basis of design are responsible for additional piping & electrical costs and are required to identify additional costs & installation time required of other trades with their bid.

B. QUALITY ASSURANCE

1. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
3. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
4. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
5. System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals.

C. DELIVERY, STORAGE AND HANDLING

1. Unit shall be stored and handled according to the manufacturer's recommendation.

2. WARRANTY

1. The CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.
2. Installing contractor shall meet manufacturer requirements to obtain extended manufacturer's limited parts and compressor warranty for a period of ten (10) years to the original owner from date of installation. This warranty shall not include labor.
3. Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the U.S. market.
4. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
5. The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

3. OUTDOOR UNITS - R2-SERIES STANDARD EFFICIENCY (HEAT RECOVERY)

A. GENERAL

1. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Part 5 (Controls). The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
2. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
3. Outdoor unit shall have a sound rating no higher than 66.5 dB(A) individually or 69.5 dB(A) twinned. Units shall have a sound rating no higher than 52 dB(A) individually or 55 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
4. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.

5. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
6. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
7. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
8. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
9. The outdoor unit shall be capable of operating in heating mode down to -18°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
10. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
11. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.
12. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature. Systems that keep fans running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.
13. In reverse defrost all refrigerant shall be bypassed in the main branch controller and shall not be sent out to the indoor units, systems that flow refrigerant through indoor units during reverse defrost shall not be allowed.

B. UNIT CABINET

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
2. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.

C. FAN

1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG. external static pressure, but capable of normal operation with a maximum of 0.32 in. WG. external static

pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fans shall be provided with a raised guard to prevent contact with moving parts.

D. REFRIGERANT AND REFRIGERANT PIPING

1. R410A refrigerant shall be required for systems.
2. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
3. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
4. All refrigerant piping must be insulated with ½” closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
5. Refrigerant line sizing shall be in accordance with manufacturer specifications. Future changes to indoor unit styles or sizes must be possible without resizing/replacing refrigerant piping to any other branch devices or indoor units.

E. COIL

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.
2. Outdoor Coil shall be elevated at least 12” from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer’s in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12” of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.
3. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
4. The coil fins shall have a factory applied corrosion resistant blue-fin finish. Uncoated aluminum coils/fins are not allowed.
5. The coil shall be protected with an integral metal guard.
6. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
7. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.

8. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed in markets where the outdoor unit will see temperatures below freezing.

F. COMPRESSOR

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
3. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturer's that utilize belly-band crankcase heaters will be considered as alternate only.
4. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.
5. The compressor shall be equipped with an internal thermal overload.
6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
7. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

G. CONTROLS

1. The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.
2. Each outdoor unit module shall have the capability of 4 levels of demand control based on external input.

H. ELECTRICAL

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.
2. The outdoor unit shall be controlled by integral microprocessors.

3. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
4. BRANCH CIRCUIT (BC) CONTROLLERS AS REQUIRED FOR SIMULTANEOUS HEAT/COOL SYSTEMS
 - A. GENERAL
 1. BC (Branch Circuit) Controllers (or comparable branch devices) shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices which do not include controlled refrigerant subcooling risk bubbles in liquid supplied to indoor unit LEVs and are not allowed.
 2. BC Controllers (or comparable branch devices) shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish and be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. BC Controllers (or comparable branch devices) shall be suitable for use in plenums in accordance with UL1995 ed 4.
 - B. BC UNIT CABINET
 1. The casing shall be fabricated of galvanized steel.
 2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
 3. The unit shall house two tube-in-tube heat exchangers.
 - C. REFRIGERANT PIPING (SPECIFICATIONS IN ADDITION TO THOSE FOR OUTDOOR UNIT)
 1. All refrigerant pipe connections shall be brazed.
 2. Future changes to indoor unit quantities or sizes served by BC Controller or comparable branch device must be possible with no piping changes except between the branch device and indoor unit(s) changing. Systems which might require future piping changes between branch device and outdoor unit—if changes to indoor unit quantities or sizes are made—are not considered equal and are not allowed.
 - D. REFRIGERANT VALVES
 1. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
 2. Service shut-off valves shall be pre-installed by the equipment vendor and leak tested to the applicable factory specifications for each branch to allow service to any indoor unit without field interruption to overall system operation.
 - E. FUTURE USE BRANCH
 1. Each VRF system shall include at least one (1) unused branch or branch device for future use. Future-use branches or branch devices shall be fully installed & wired in central location with capped service shutoff valve & service port.

F. CONDENSATE MANAGEMENT

1. BC Controller (or comparable branch device) must have integral resin drain pan or insulate refrigeration components with removable insulation that allows easy access for future service needs. Cabinets filled with solid foam insulation do not allow for future service and are not allowed.

G. ELECTRICAL

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).
2. The BC Controller shall be controlled by integral microprocessors
3. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

5. INDOOR UNITS - MEDIUM STATIC CEILING-CONCEALED DUCTED INDOOR UNIT

A. GENERAL

1. The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. UNIT CABINET

1. The unit shall be ceiling-concealed, ducted—with a 2-position, field adjustable return and a fixed horizontal discharge supply.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

C. FAN

1. Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.
2. The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.
3. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function

D. FILTER

1. Return air shall be filtered by means of a standard factory installed return air filter.
2. Optional return filter box (rear or bottom placement) with high-efficiency filter as noted on equipment schedule.

E. OPTIONAL FILTER FRAME AND FILTER

1. Filter frame shall be constructed of 20 gauge G-60 galvanized steel. Knurled thumb screws on access door allow filter replacement. Foam gasket provides air-tight connection to indoor unit and access door. Filter frame shall be configurable for rear or bottom return.
2. Filter shall be rated MERV 13 when tested in accordance with ANSI/ASHRAE 52.2 Standard Rated Class 2 under U.L. Standard 900.

F. COIL

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.
4. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

G. ELECTRICAL

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. CONTROLS

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
5. Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.
6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

6. CONTROLS

A. OVERVIEW

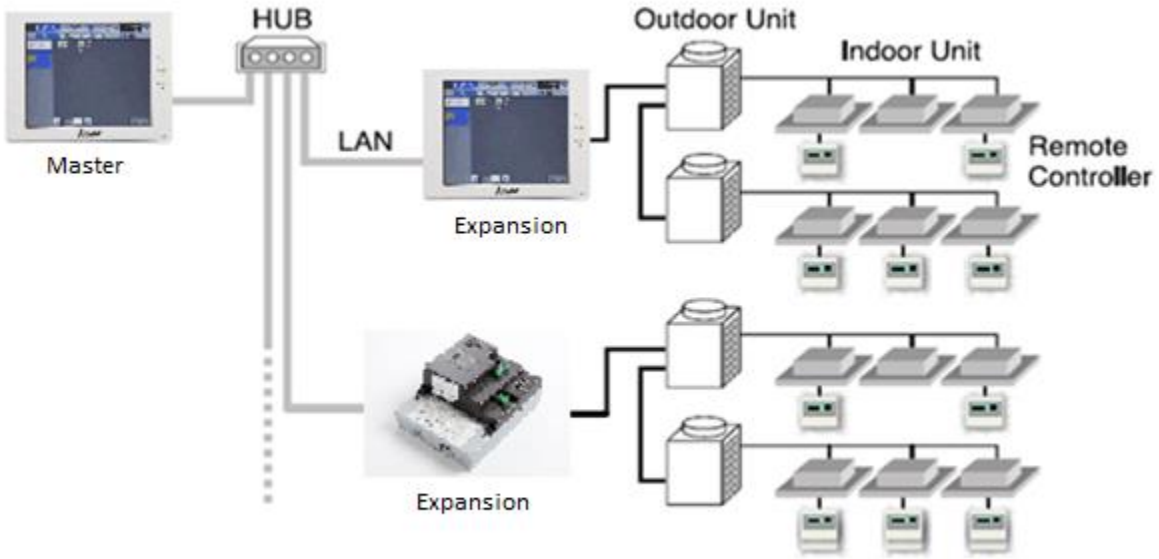
1. The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
2. Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
3. System shall be capable of email generation for remote alarm annunciation.

B. ELECTRICAL CHARACTERISTICS

1. Controller power and communications shall be via a common non-polar communications bus and shall operate at 30VDC.
2. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
3. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
4. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
5. Network wiring shall be CAT-5 with RJ-45 connection.

C. CITY MULTI CONTROLS NETWORK

1. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



CMCN System Configuration

D. CMCN: REMOTE CONTROLLERS - SIMPLE MA REMOTE CONTROLLER

1. The Backlit Simple MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group).
2. The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers or with other Backlit Simple MA Remote Controllers, with up to two remote controllers per group.

Simple MA Remote Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit.	Each Group	Each Group

Simple MA Remote Controller			
Item	Description	Operation	Display
	Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.		
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display "test run").	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

E. CENTRALIZED CONTROLLER (WEB-ENABLED)

1. Master Centralized Controller:

The Master Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three expansion controllers. The Master Centralized Controller shall be approximately 11-5/32" x 7-55/64" x 2-17/32" in size and shall be powered with an integrated 100-240 VAC power supply. The Master Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the Master Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Master Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the master provides centralized control, it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Master Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

Master Centralized Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group

Master Centralized Controller			
Item	Description	Operation	Display
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can be scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter).	Each Block, Group or Collective	*3 Each Group

Master Centralized Controller			
Item	Description	Operation	Display
	Centrally Controlled is displayed on the remote controller for prohibited functions.		
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following languages can be selected: Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese.	N/A	Collective

Master Centralized Controller			
Item	Description	Operation	Display
External Input / Output	<p>By using accessory cables you can set and monitor the following.</p> <p>Input</p> <p>By level: "Batch start/stop", "Batch emergency stop"</p> <p>By pulse: "batch start/stop", "Enable/disable remote controller"</p> <p>Output: "start/stop", "error/Normal"</p> <p>Requires the external I/O cables (PAC-YG10HA-E) sold separately.</p>	*5 Collective	*5 Collective

2. All Master Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three expansion controllers for display of up to two hundred (200) indoor units on the main master centralized controller interface.
3. The Master Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.
4. Standard software functions shall be available so that the building manager can securely log into each master centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Energy shall be available but are not included. The Energy Apportionment function shall require a LIC-Charge software license

F. GRAPHICAL USER INTERFACE

The Graphical User Interface (Integrated Centralized Control Web) shall require a field supplied PC or Tablet.

1. ICCW

The Integrated Centralized Control Web System (ICCW) interface shall enable the user to control multiple networked central controllers and shall provide additional functions such as energy apportionment from a single network PC configured with the Charge Calculation Tool. The ICCW shall be capable of controlling up to forty networked Centralized Controllers with a maximum of 2,000 indoor units across multiple CITY MULTI outdoor units. The ICCW shall be required if the user wants to simultaneously control

more than 1 Centralized Controllers from a single PC or tablet using a single web browser session. Licensing per function, per Centralized Controller shall be required for the ICCW. Optional software features shall be available through the ICCW including energy apportionment and personalized web. These optional software features shall require the ICCW, advance purchase from the customer, and licensing from ICCW.

ICCW (Integrated System Software)	
Item	Details
ON/OFF	The units can turn ON and OFF for all floors or in a block, floor, or group of units.
Operation Modes	The operation mode can be switched between COOL, DRY, FAN, AUTO, and HEAT for all floors or in a block, floor, or group of units
Temperature Setting	Sets the temperature for a single group. Range of Temperature setting from 57°F – 87°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.
Fan Speed	The fan speed can be set to four stages for all floors or in a block, floor, or group of units
Air Direction	The air direction can be set in four vertical directions or to swing for all floors or in block, floor, or group of units. (The selectable air direction differs according to the model.)
Interlocked Unit ON/OFF LOSSNAY	If there is an interlocked unit (LOSSNAY), then the unit can be turned ON (strong/weak) or OFF for all floors or in a block, floor, or group of units. (Note that the ventilation mode cannot be selected for interlocked units.)
Local Operation Prohibit	The items for which operation with the local remote controller are to be prohibited can be selected for all floors or in a block, floor, or group of units. (The items that can be prohibited are ON/OFF, operation mode, set temperature and filter sign reset.)
Annual / Weekly Schedule	The annual/weekly schedule function can be used by registering the license. Two settings, such as seasonal settings for summer and winter, can be saved.
Power Rate Apportionment Charging	A watt-hour meter (WHM) with kWh pulse output is connected to calculate the air conditioning charges based on the amount each tenant's air-conditioner has operated. Five charging rates can be applied per day.

ICCW (Integrated System Software)	
Item	Details
	***OPTIONAL ENERGY APPORTIONMENT SOFTWARE (LIC-CHARGE) and PI Controller (PAC-Y60MCA) REQUIRED
History	Up to 3,000 items for the error history and up to 10,000 items for operation history can be saved. Each history file can be output as a daily report or monthly report in CSV format. (The operation history consists only of the operations carried out with the ICCW and is limited to some limited operation items.)
Operation Time Monitor	The cumulative operation time of each indoor unit can be viewed or output as a CSV format file. (This function is valid only when the charging function license is registered.)
Filter Sign Display Mask	The filter sign display at the remote controllers can be disabled.
Set Temperature Limit	The set temperature lower limit can be set for cooling and the upper limit for heating. (ME remote controller required)

SECTION 250100 - MOTOR STARTERS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. MOTOR STARTERS-GENERAL

- A. Where motor starters are required for mechanical equipment, they are to be the responsibility of the Contractor furnishing the equipment as outlined herein.
- B. Motor starters shall be furnished by the Equipment Supplier with his equipment. Coordinate all requirements for starters with equipment suppliers and other trades.
- C. Motor starters shall be NEMA style. I.E.C.-style starters are not to be provided. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.
- D. Unless otherwise noted, provide combination starter/disconnects for all equipment requiring a starter.

2. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. All mechanical equipment shall be provided for single point electrical connection unless specifically noted to the contrary. Refer to schedules and other sections of these specifications for further requirements. It is the responsibility of the Contractor to coordinate the electrical characteristics of all equipment with the electrical provisions indicated on the Contract Documents. The Contractor shall notify the Engineer in writing ten calendar days prior to bid of any discrepancy so a written clarification by Addendum may be made. If such notice is not given, the Contractor shall be responsible for any and all costs or delays associated with any changes required. Specification of equipment characteristics made during review of shop drawings shall not relieve the Contractor of this responsibility.
- B. The equipment manufacturer shall provide internally mounted fuses with his equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, and other applicable sections of the N.E.C.
- C. It is the Contractor's responsibility to furnish and install fusible or non-fusible disconnect switches or circuit breakers for disconnecting means as required by the Code for all electrically powered equipment. All power wiring from source, thru disconnecting means and motor starters to motor terminals or equipment junction box is to be furnished and installed by the Contractor. Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per code requirements. Unless otherwise notes, provide combination starter/disconnects for all equipment requiring a starter.
- D. Final electrical connection of equipment shall be verified for proper voltage requirements in conjunction with the motor nameplate patch and actual wiring configuration. Any costs

associated with damage to appliances motors, equipment, etc., connected to incorrect supply voltage shall be borne by the Contractor.

- E. Refrigeration condensing units with internal compressors shall be furnished with integral starter. The Contractor is to furnish and install a fusible disconnecting means with fuses sized to motor nameplate requirements. Coordinate wiring, mounting and style of disconnect switch at unit in field.
- F. All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of the Contractor.
- G. All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.
- H. Observe the following standards for manufacturers of equipment and selection of components.
 - (1) Starters, control devices and assemblies: NEMA, U.L. - (I.E.C. style not acceptable)
 - (2) Enclosures for electrical equipment: NEMA, U.L.
 - (3) Enclosed switches: NEMA, U.L.
 - (4) All electrical work, generally: National Electrical Code
 - (5) All electrical work in industrial occupancies: J.I.C. standards
 - (6) All electrical components and materials: U.L. listing required.
- I. Where required, the Contractor is to provide mounting rails or channels to install starters with code-required clearances. Framing shall be solidly anchored by welding expansion shields in masonry or other approved anchorage. Frames are to be constructed of steel angles or pre-manufactured channel systems such as Unistrut, Kindorf or B-Line Company. Framing material shall be pre-finished with corrosion-resistant material or painted with two coats corrosion-resistant oil-based enamel.

3. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 1/2 H.P OR LESS

- A. This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, (water source heat pumps, etc.) VAV boxes, unit heaters, vertical and horizontal unit ventilators, exhaust fans, in-line fans, fan coil units, cabinet heaters and the like.
- B. Small equipment with motor(s) of 1/2 H.P., single phase or less are generally not required to be furnished with NEMA-style starter(s), unless otherwise noted.

- C. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment, suitable for the service duty.
- D. Provide transformer within unit as required to derive low voltage A.C. for thermostat control or derive from temperature controls panel, if available.
- E. Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder. See also Article 2-B, this Section.
- F. Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction. Refer to mechanical equipment schedules for further information.
- G. Where fractional horsepower duplex pumps such as water circulators, sump pumps, etc. are provided, they shall be provided with alternators, cordsets, etc., as required for a complete installation.

4. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 3/4 H.P. OR LARGER

- A. This section describes requirements for mechanical equipment such as (but not limited to) exhaust fans, larger air handling units, cooling tower fans, water source heat pumps, chilled or hot water pumps, D.X. roof-top units, air compressors and the like.
- B. Provide premium efficiency motors.
- C. Equipment provided with motor(s) of 3/4 H.P. and larger, single or three-phase are required to be furnished with starters suitable for the load(s) specified. It is recommended that starters be furnished integrally with or mounted on equipment for field wiring by the Contractor. Where starters are furnished separate from equipment, furnish templates or rough-in diagrams to the appropriate contractor for his use in installation.
- D. All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be of the wye-delta, reduced voltage open-transition type, or electronic controlled, as required. Do not utilize closed transition starters unless specifically indicated.
- E. Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See other sections of these specifications and mechanical schedules for further requirements.

- (1) Contacts shall be silver-alloy, double-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.
- (2) Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, rated for continuous duty. Provide coil clearing contact as required.
- (3) Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.
- (4) Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated on plans or schedules for automatic control. Provide a green run pilot light.
- (5) Provide NEMA Class 20 resettable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resettable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used, depending on the type of anticipated service.
- (6) Provide at least one N.O. and one N.C. auxiliary contact (field-convertible to opposite operation) with each starter. Refer to mechanical details or schedules for additional requirements, if any. All starters shall have space for two additional single-pole contacts.
- (7) All starters shall be thru-wiring type.
- (8) Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 15 H.P. or larger.
- (9) Provide power factor correction capacitors on motors of 15 H.P. or larger where predicted power factor based on manufacturer's data will fall below 0.90%. Capacitors shall be of the unit-cell type, in single enclosure with discharge resistors and tank overpressure circuit interrupter for safety.

5. REQUIREMENTS FOR WIRING

- A. All wiring, including controls, interlock, miscellaneous power, sensors, thermostats, etc., shall be installed in metallic raceway systems that are in compliance with all Division 26 requirements of these Specifications, unless specifically noted otherwise. Open cabling systems will only be permitted where specifically permitted within the Division 26 Specifications and if less than 50 volts A.C. peak-to-peak or 50 volts maximum D.C.

- B. Where open cabling is permitted, it shall be installed with proper support as specified in the Division 26 Specifications.
- C. Where open cabling is permitted, and installed in environmental air plenum (return, relief, supply, etc.), the materials installed shall be in compliance with N.E.C. Articles 700, 725, 770 (for fiber optic), 780 and 800.
- D. Where open cabling is permitted, it shall only be installed open in accessible spaces. Where concealed in walls, it shall be routed through raceways to outlet box(es) for the terminal device.

6. INVERTER DUTY MOTORS

- A. Motors which are controlled by variable frequency drive shall be:

- (1) NEMA MG-1 Part 31 rated for Inverter Duty.

- (2) Furnished with shaft grounding kit for all motors:

- a. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.
 - b. Motors Pumps greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer's instructions. Additionally, provide insulated bearing journals to further reduce risk of current dissipation through bearings. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

END OF SECTION 250100

SECTION 250200 - CONTROLS – DIRECT DIGITAL

1. GENERAL

- A. The Contractor shall furnish all labor, materials, equipment and services required to provide a complete temperature control system as specified and as shown on the plans.
- B. Prior to the installation of or payment for any work, the Contractor shall prepare submittals which shall be reviewed by the Architect and Engineer. These submittals shall include a complete control diagram and sequence of operation of the entire system, plus engineering data on all devices used.
- C. The Contractor shall be a licensed installer of HVAC temperature controls by a national temperature controls manufacturer. Acceptable manufacturer shall be Trane. The installer shall have 5 years experience and installed a minimum of 8 systems of similar size. Their offices shall be within 150 miles of the project site.
- D. The system herein specified shall be free from defects in workmanship and material under normal use and service if, within twelve (12) months from the date of acceptance by the Engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be adjusted, repaired, or replaced free of charge by the Contractor.
- E. All equipment, unless specified to the contrary, shall be fully proportioning and adjustable. The Control System shall consist of all room thermostats, air stream thermostats, valves, damper operators, relays, freeze protection equipment, dampers, panels, and other accessory equipment not provided with the equipment to fill the intent of the specifications and drawings.
- F. Complete freeze protection equipment shall be provided at all required locations. Freeze protection thermostats shall have twenty-foot elements and be capable of de-energizing the circuit when any point along the element reaches the set point of the thermostat. Freezestat elements shall be placed on the leaving side of each heating coil, so that every square foot on the heating coil is protected. On heating coils larger than eighteen (18) square feet, provide multiple freezestats wired in series. The Contractor shall ensure that all freeze protection devices and equipment has been fully tested prior to the heating season and shall so certify in writing to the Engineers. The cost of replacement of equipment damaged by freeze-up caused by improper freeze protection or faulty control equipment shall be borne by the Contractor.
- G. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.
- H. All control wiring concealed in walls and exposed in mechanical rooms, closets, etc., shall be in conduit. Provide plenum rated wiring where cable is concealed above ceilings. Do not paint wiring. The Contractor is responsible for protecting wiring from paint. Any painted cabling shall be replaced.

- I. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.
- J. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.
- K. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the IBC and IMC.
- L. All DDC controllers or control modules shall have covers to protect the circuit boards. All wiring shall be anchored securely within 6" of the controller.
- M. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.
- N. The Contractor shall provide all refrigeration control and interlock wiring as recommended by the equipment manufacturer.
- O. Wiring and required conduit in connection with the control system(s), including power wiring of any voltage, shall be installed by the Contractor. The Contractor may, at his option, engage the Electrical Contractor to accomplish this work. It is emphasized however, that the Contractor is finally responsible for all such work.
- P. Electric power for the control panels, modules, unit controller, damper motors, etc., shall be derived from the building electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral).
- Q. The electrical work required for the installation of the control system(s), shall be provided by the Contractor in accordance with all National and Local Electrical Codes. All wiring shall be concealed except in Mechanical Rooms. All electrical work specified under this division of the specifications shall also comply with Division 26 of these specifications.
- R. All exterior electrical work, equipment, etc. shall be waterproofed.
- S. Controls system and all related components shall comply with ASHRAE Standard 135 (BACnet protocol).

2. OWNER'S TRAINING

- A. The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed. Four hours of Owner Training shall be provided at substantial completion, again after 6 months and again 1 year after substantial completion. The Owner Training shall include an overview of the entire HVAC system operation, temperature sensor setpoint manipulation, critical alarm training and graphics display overview. Subcontractors shall be present during Owner training sessions.

B. The Contractor shall provide a Sign-in Sheet and Meeting Minutes of the training. The Contractor shall also video record the initial training sessions. Complete Operations and Maintenance Manuals shall be reviewed by the Contractor during training.

3. CONTROL SYSTEM CHECKOUT AND TESTING – BY CONTROLS CONTRACTOR PRIOR TO DEMONSTRATION AND ACCEPTANCE

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.

- (1) Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 250200.
- (2) Verify that control wiring is properly connected and free of shorts and ground faults.
- (3) Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
- (4) Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
- (5) Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
- (6) Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
- (7) Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
- (8) Alarms and Interlocks.
 - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

4. EQUIPMENT

A. CONTROL PANEL(S)

- (1) Each system shall be provided with a local panel for mounting of all relays, switches, controllers, and thermometers associated with that system. Where one cabinet will not accommodate all the equipment necessary for one system, a second cabinet shall be mounted and bolted adjacent to it. Cabinets shall be provided with a 2/3's door. All devices shall be provided with lamacoid plastic nameplates for identification.

B. THERMOSTATS

(1) General

- a. All thermostats shall have a "warmer-cooler" knob. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount, or no amount at all, shall be settable thru the BAS.
- b. The thermostat shall have an unoccupied override button and an integral communications port.
- c. The thermostat shall have no integral thermometer.
- d. All thermostats provided for the project shall be similar in size and appearance.
- e. Provide tamper-proof guards for all wall mounted thermostats selected by Owner.
- f. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
- g. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
- h. Thermostats shall provide temperature dead band of 5° F as required by IECC 2012.
- i. Thermostat, or any other DDC sensor back box in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer, provide rated box or fireproofing in code approved manner.

C. DAMPERS

- (1) Several louvers of practical widths shall be provided for larger dampers. Modulating dampers shall have opposed blades. Dampers shall have edge and end seals. Dampers shall be Ruskin CD-60 or better. Maximum leakage rate shall be 2 CFM per square foot at 1" W.G. pressure differential for dampers greater than 12" wide. Leak rate for dampers 12" and less shall be 3 CFM per square foot. NOTE: Do not mount outside air dampers so close to water coils, piping, etc., that freeze-up may occur due to a leaky damper.

D. RELAYS AND SWITCHES

- (1) Relays and switches shall be of the positive and gradual acting type and shall be furnished and installed as required for the successful operation of the system. All switches shall have suitable indicating plates.

E. VALVES

(1) All valves shall be of the fully modulating and silent type unless otherwise specified. They shall provide accurate control of the heating or cooling medium under all load conditions. All valves 2-inches or smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2 inches and larger shall have iron bodies, brass or bronze trimming with flange ends. Valves shall be normally open or normally closed as required. Valves shall be installed with the stem in the upright position or as recommended by the valve manufacturer.

5. DEMONSTRATION

A. A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall demonstrate on -site with the Owner and Engineer that all points and sequences operate as designed.

The warranty does not start until all controls, graphics, points, etc. are functioning.

All controls functioning on _____ Date

Witnessed by _____

END OF SECTION 250200

SECTION 260501 - GENERAL PROVISIONS - ELECTRICAL

1. GENERAL

- A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.
- B. The Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.
- C. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating electrical systems indicated on the drawings and/or specified herein.
- D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the electrical systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.
- E. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.
- F. This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.
- G. It is the intent of this Contract to deliver to the Owner a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems

which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

- H. The Contractor shall provide interim life safety and fire detection measures as required by the Authority Having Jurisdiction, Division 1 specifications, NFPA, and applicable Codes. This includes temporary relocations of heat/smoke detection, exit signage, and egress lighting in existing buildings as applicable.
- I. In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer (as applicable) in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.
- J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without request for extra compensation to the Owner, except where otherwise provided for in the contract document.
- K. Definitions:
 - (1) Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.
 - (2) Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

Note: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.
 - (3) Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.
 - (4) Engineer - The Consulting Mechanical-Electrical Engineers, either consulting to the Owner, Architect, other Engineers, etc.

- (5) Architect - The Architect of Record for the project, if any.
- (6) Furnish - Deliver to the site in good condition.
- (7) Provide - Furnish and install in complete working order.
- (8) Install - Install equipment furnished by others in complete working order.
- (9) Contract Documents - All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

2. INTENT

- A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."
- B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

3. ELECTRICAL DRAWINGS AND SPECIFICATIONS

- A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for review before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.
- B. The drawings and specifications are intended to supplement each other. No Contractor or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.
- C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or

conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

- D. The Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
- E. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.
- F. The Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.
- G. Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.
- H. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
- I. The drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.
- J. The Contractor and his Sub Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.
- K. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

4. EXAMINATION OF SITE AND CONDITIONS

- A. The Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors or suppliers shall carefully examine all Drawings and Specifications and contract documents to determine the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.
- B. The Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. The Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

- A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility
- B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of paragraph (A) immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten days prior to bid date for approval to bid in written form thru addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.
- C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.
- D. The Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the

Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

- E. The Contractor shall review the contract documents and if a material substitution form is required for each proposed substitution, it shall be submitted per requirements.

6. SUPERVISION OF WORK

- A. Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

7. CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

- A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.
- B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.
- C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.
- D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.
- E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.
- F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.
- G. The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

- H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

8. COST BREAKDOWNS/SCHEDULE OF VALUES

- A. Within thirty days after acceptance of the Contract, the Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to the end of this section for a sample of expected level and breakout being required.

9. CORRECTION PERIOD

- A. All equipment, apparatus, materials, etc., shall be the best of its respective kind. The Contractor shall replace all materials at his own expense, which fail or are deemed defective as described in the General Conditions. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Architect or Engineer as being substantially complete.
- B. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

10. INSPECTION, APPROVALS AND TESTS

- A. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.
- B. The Contractor shall provide as part of this contract electrical inspection by a competent Electrical Inspection Agency (local or state as specific to project), licensed to provide such services in the

State of West Virginia. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

- C. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.
- D. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.
- E. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.
- F. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.
- G. The Contractor shall test all wiring and connections for cross connects, continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by continuity/load/voltage test and Megger Test the installation of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, replacing same with new and demonstrate by further test the elimination of such defect. The secondary service entrance conductors from the utility (source) transformer to the main service disconnecting means shall be megger tested. The results of this test shall be turned over to the engineer for review and approval. Any conductor failing the test shall be replaced and any costs associated shall be borne by the contractor.

11. COMPUTER-BASED SYSTEM SOFTWARE

- A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

12. CHANGES IN ELECTRICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEYS, MEASUREMENTS AND GRADES

- A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.
- B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

15. TEMPORARY USE OF EQUIPMENT

- A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.
- B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

16. TEMPORARY SERVICES

- A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid. The contractor may use existing service but will be responsible for all bills/fees with utility company.

17. RECORD DRAWINGS

- A. The Contractor shall insure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed,

visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically to the Engineer in AutoCad 2000 format (or more recent version) along with the hand marked field set. Electronic bid drawings will be furnished to the Contractor for his use at the completion of the work.

18. MATERIALS AND WORKMANSHIP

- A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).
- B. All conduit and/or conductors shall be concealed in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.
- C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.
- D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.
- E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.
- F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

19. QUALIFICATIONS OF WORKMEN

- A. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for

relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

- B. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.
- C. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

20. CONDUCT OF WORKMEN

- A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

21. COOPERATION AND COORDINATION BETWEEN TRADES

- A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be effected.
- B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements.

22. PROTECTION OF EQUIPMENT

- A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor.

23. CONCRETE WORK

- A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.
- B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than 18" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

- C. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads 18" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.
- D. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, trowelled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

24. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

- A. The Contractor shall restore to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable.

25. MAINTENANCE OF EXISTING UTILITIES AND LINES

- A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also see Article 1. - General, this section.
- B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain that no utilities or lines, known or unknown, are endangered by the excavation.
- C. If the above mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.
- D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.
- E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
- F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.
- G. Protect all new or existing lines from damage by traffic, etc. during construction.
- H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

26. SMOKE AND FIRE PROOFING

- A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

27. QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

- A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.
- B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.
- C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

28. FINAL CONNECTIONS TO EQUIPMENT

- A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturers representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

29. WELDING

- A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

30. ACCESSIBILITY

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.
- B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.
- C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.
- D. Access Doors; in Ceilings or Walls:
 - (1) In mechanical, electrical, or service spaces:

14 gauge aluminum brushed satin finish, 1" border.
 - (2) In finished areas:

14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
 - (3) In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

31. ELECTRICAL CONNECTIONS

- A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also refer to Divisions 11, 14, 20, 21, 22, 23 and 25 of the Specifications, shop drawings and equipment schedules for additional information.

- B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.
- C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

32. MOTORS

- A. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and N.E.C. required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.
- B. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 20, 22 and 23 of the Specifications for further requirements and scheduled sizes.
- C. All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

33. CUTTING AND PATCHING

- A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.
- B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and

electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

34. ANCHORS

- A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

35. WEATHERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.
- B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

36. OPERATING INSTRUCTIONS

- A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.
- B. Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- C. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

D. Formatting & content shall follow the guidelines outlined in the latest version of ASHRAE Applications Handbook, Guideline 4. As a minimum, the following shall be included:

- The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:
 - I. General Information
 - a. Building function
 - b. Building description
 - c. Operating standards and logs
 - II. Technical Information
 - a. System description
 - b. Operating routines and procedures
 - c. Seasonal start-up and shutdown
 - d. Special procedures
 - e. Basic troubleshooting
- The maintenance manual should contain the following information:
 - I. Equipment data sheets
 - a. Operating and nameplate data
 - b. Warranty
 - II. Maintenance program information
 - a. Manufacturer's installation, operation, and maintenance instructions
 - b. Spare parts information
 - c. Preventive maintenance actions
 - d. Schedule of actions
 - e. Action description
 - f. History
- Test reports document observed performance during start-up and commissioning.

37. SCAFFOLDING, RIGGING AND HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

38. CLEANING

- A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.
- B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

39. PAINTING

- A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

40. INDEMNIFICATION

- A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

41. HAZARDOUS MATERIALS

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during

construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

- B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.
- C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.
- D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

42. ABOVE-CEILING AND FINAL PUNCH LISTS

- A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:
 - (1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.
 - (2) For review of all other work as the project nears substantial completion.
- B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.
- C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of \$140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.



Phone: (502) 262-0316

The following is CMTA’s guide for required electrical information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job.

Electrical

Description of Work	Scheduled Value	Labor	Material
Shop Drawings			
Mobilization/Permits			
Temporary Utilities			
Demolition			
Site Utilities			
Branch Panels			
Feeder Conduit			
Branch Conduit			
Feeder Wire			
Branch Wiring			
Fire Alarm Conduit & Wiring			
Fire Alarm Devices			
Cabletray & Accessories			
Light Fixture Interior			
Light Fixture Exterior			
Lighting Control System			
Wiring Devices			

Surge Suppression			
CCTV System Conduit			
Intrusion Detection Conduit			
Voice/Data System Conduit			
Audio/Video System Conduit			
Low Voltage Cable Pulling			
Electrical Inspection			
Owner Training			
Record Drawings			
O & M Manuals			
Punch List / Closeout			

END OF SECTION 260501

SECTION 260502 - SCOPE OF THE ELECTRICAL WORK

1. GENERAL

Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

2. SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

- A. All conduits, conductors, outlet boxes, fittings, etc.
- B. All panels, disconnect switches, fuses, contactors, starters, etc.
- C. Fault Current, Arc Flash and Coordination Studies.
- D. All wiring devices and device plates.
- E. All light fixtures.
- F. Diesel Generator and all transfer switches and connections as part of Alternate.
- G. Electrical connection to all electrically operated equipment furnished and/or installed by others, including powered casework, kitchen equipment, etc.
- H. Digital video surveillance system-rough-in only and cable pulling.
- I. Access Control and Intrusion Detection system rough-in only and cable pulling.
- J. Voice/Data wiring system – rough-in only and cable pulling.
- K. Pulling all low voltage cabling as furnished by owner and coordinated with them to the specific locations. OWNER TO PROVIDE LOW VOLTAGE EQUIPMENY AND INSTALL / MAKE FINAL TERMINATIONS.
- L. Expansion of existing fire alarm system.
- M. All necessary coordination with electric utility company, telephone company, cable television company, etc. to ensure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
- N. Owner to pay all necessary fees by utility companies (power, telephone, CATV, etc).

- O. Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid.

- P. Obtaining, coordinating and paying all necessary fees and costs for permits and inspections required by local, state and federal law. The Contractor shall contact the appropriate agencies prior to submitting a bid to determine exactly these charges will be.

END OF SECTION 260502

SECTION 260503 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

- A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, seven sets of shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.
- B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.
- C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
- D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.
- E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Power Equipment

- Fault current coordination study (submit along with panelboards).
- Panelboards.
- Circuit breakers, per each type.
- Power and lighting contactors.
- Disconnect switches and Fusible Disconnect Switches
- Transient voltage surge suppression system.
- Diesel Generator and all associated transfer switches, components, etc.... as part of Alternate

Raceways

- Cable tray and each type of cable tray fitting.
- Wireways and each type of wireway fitting.
- J-hook or Bridle ring assemblies.

Devices

- Each type of wiring device and their coverplates.
- Data/voice/video wallplates, each by type.
- Any special items not listed above.

Lighting

- Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
- Photocells, time clocks or other lighting accessories.
- Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

Systems

Note: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment, provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

- Fire alarm system.

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.

2. SPECIAL WRENCHES, TOOLS AND KEYS

- A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. FIRE ALARM SHOP DRAWINGS

- A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to the Contractor's submittal to the authority for their review. No work shall be done until drawings are approved by the local authority/plan reviewer.

4. MAINTENANCE AND OPERATION MANUALS

- A. Prior to substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:
 - The **operation and maintenance document directory** should provide easy access and be well organized and clearly identified.
 - **Emergency information** should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
 - **The operating manual** should contain the following information:
 - I. General Information
 - a. Building function
 - b. Building description
 - c. Operating standards and logs
 - II. Technical Information
 - a. System description

- b. Operating routines and procedures
 - c. Seasonal start-up and shutdown
 - d. Special procedures
 - e. Basic troubleshooting
- **The maintenance manual** should contain the following information:
 - I. Equipment data sheets
 - a. Operating and nameplate data
 - b. Warranty
 - II. Maintenance program information
 - a. Manufacturer's installation, operation, and maintenance instructions
 - b. Spare parts information
 - c. Preventive maintenance actions
 - d. Schedule of actions
 - e. Action description
 - f. History
- **Test reports** document observed performance during start-up and commissioning.

END OF SECTION 260503

SECTION 260504 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

- A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.
- B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, buss duct, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the building by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.
- C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.
- D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- F. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.
- G. In all cases, sleeves shall be at least two inches larger than nominal pipe diameter.
- H. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. Any roof penetration shall not void or lessen the warranty in any way.
- I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

- J. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Architect.
- K. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Architect.
- L. All work improperly done or not done at all as required by the Contractor will be performed by others. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

2. SLEEVES, PLATES AND ESCUTCHEONS

- A. The Contractor shall provide and locate all sleeves required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.
- B. Conduits that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.
- C. At all other locations either pipe sleeves or core drilled openings are acceptable.
- D. Where thermal expansion does not occur, the wall may be sealed tight to the conduit.
- E. Sleeves shall be constructed of rigid steel conduit. Sleeves in floors shall extend 6" above finished floor level.
- F. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.
- G. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.
- H. Escutcheon plates shall be provided for all conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the sleeves.

END OF SECTION 260504

SECTION 260505 - DEMOLITION, RESTORATION AND SALVAGE

1. GENERAL

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and all other divisions of these specifications apply to work specified in this section.

2. DESCRIPTION OF WORK

- A. This section covers all demolition, restoration and salvage required to perform the electrical work indicated on the drawings, specified and/or as required to complete the project. It is the intent of this section of work to remove all existing electrical equipment, materials, etc. which are not required for the completed building and to restore any and all finished surfaces to their original type and conditions. To accomplish these requirements, the Contractor(s) shall, at his own expense, engage the services of others already performing finish work on this project. All work shall be completed to the satisfaction of the Architect/Engineers whose decisions shall be final. This requirement shall apply to all restoration work whether indicated or specified.
- B. The Contractor shall lawfully dispose of any removed P.C.B.-bearing ballasts (containing polychlorinated biphenyl), and all mercury-vapor bearing lamps, in accordance with all state, local, federal and other applicable laws and regulations.
- C. Remove all conduit and abandoned cabling associated with owner removal of radio tower where new building will be constructed.

3. ELECTRICAL

- A. Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas. In concealed areas, materials shall be abandoned in place or removed as indicated and patch all openings.
- B. The Contractor shall be responsible for the removal and/or relocation of any electrical equipment, fixtures, devices, appurtenances, etc., which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical, Electrical, Structural or Fire Protection Systems whether indicated or not.

4. REPAIR

- A. Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where electrical equipment is removed.

5. SALVAGE

- A. It is the intent of this section to deliver to the Owner all components of any electrical system which may be economically reused by him. The Contractor shall make every effort to remove

reusable components without damage and deliver them to a location designated by the Owner.
Prior to demolition, walk site with Owner to determine any equipment they may want to salvage.

END OF SECTION 260505

SECTION 260508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

- A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.
- B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.
- C. The Contractor shall be responsible for coordination with all trades to ensure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc., that are required for equipment operation shall be provided as a part of this contract.
- D. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.
- E. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

2. INTERFACING

Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

- A. Connection of all controls to equipment.
- B. Electrical power connections to electrically operated (or controlled) equipment.
- C. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

- A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.
- B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.
- C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.
- D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.
- E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.
- F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

END OF SECTION 260508

SECTION 260519 - CONDUCTORS, IDENTIFICATION, SPLICING DEVICES & CONNECTORS

1. GENERAL

- A. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.
- B. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.
- C. **No more than 40% conduit fill is permitted for any conduit system, including video, intercom, data, power or other signal circuits unless specifically indicated otherwise on the plans.**
- D. Lighting circuits: No more than five conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.
- E. Receptacle circuits: If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors are permitted in a single conduit. Conductors shall be derated per N.E.C.
- F. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

2. MATERIALS

A. CONDUCTORS

- (1) All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled.
- (2) Lighting and receptacle branch circuits shall be not less than No. 12 copper wire or of the sizes shown on the drawings with Type THW, THHN or THWN insulation. All feeder circuits shall be Type THW or THWN of the size as shown on the Contract Drawings. THHN wiring shall only be installed in overhead, dry or damp locations. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.
- (3) Conductors No. 10 and smaller sizes of wire shall be solid. Conductors No. 8 and larger sizes shall be stranded.

- (4) Conductors for fire alarm wiring shall be stranded and in full compliance with N.E.C. 760. All fire alarm conductors shall be installed within conduit and enclosed junction boxes.
- (5) All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.
- (6) The color of the wire shall be selected to conform with Section 210-5 of the latest edition of the National Electrical Code. Refer also to 260519-4, Color Coding.
- (7) All equipment grounding conductors shall have green color insulation or if larger than #8, shall be taped for two inches, green color at every termination and pullbox access point.
- (8) Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.
- (9) Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.
- (10) All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit No. or terminal No.
- (11) Branch wiring and feeder conductors that are greater than 100' in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.
- (12) No aluminum conductors shall be used.
- (13) **MC CABLE IS ALLOWED FOR BRANCH RECEPTACLES AND LIGHTING CIRCUITS. IT IS NOT ALLOWED FOR HVAC/PLUMBING CONNECTIONS. MC CABLE MUST BE INSTALLED AND SECURED TO STRUCTURE ABOVE IN A NEAT WAY PRIOR TO PAINTING. WHERE NEW DEVICES ARE LOCATED ON EXISTING WALLS, EMT CONDUIT MUST BE INSTALLED TO STRUCUTRE SPACE AND THEN CAN TRANSITION TO MC CABLE.**

B. SPLICING DEVICES & CONNECTORS

- (1) Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent.
- (2) Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.
- (3) Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor

and equipment leads or on all stranded wire terminations using No. 10 AWG or smaller conductors.

- (4) Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.
- (5) Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.
- (6) Exterior underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.
- (7) The use of split-bolt clamps will be permitted in wireways at service entrance only. Torque to 55 foot-pounds or as recommended by manufacturer.

3. INSTALLATION

- A. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.
- B. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.
- C. Conductors installed within environmental air plenums shall be per N.E.C. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.
- D. Where indicated, communications conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.
- E. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.
- F. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment

as required to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.

- G. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 6 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical, provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

4. COLOR CODING DISTRIBUTION VOLTAGE CONDUCTORS, 600 VOLT OR LESS

- A. Conductors to be color coded as follows:

- (1) 120/208 Volt Conductors

- Phase A - Black

- Phase B - Red

- Phase C - Blue

- Neutral - Solid White or White with tracer stripe to match phase conductor

Note: Further identify isolated power conductors with 2" wide purple tape at all terminations and junctions.

- (2) Control Wiring - Red, or as indicated.

- (3) Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.

- (4) D.C. Wiring - Positive - Light Blue

- Negative - Dark Blue

END OF SECTION 260519

SECTION 260526 - GROUNDING

1. GENERAL

- A. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.
- B. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.
- C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.
- D. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

2. MATERIALS

- A. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accord with the prevailing codes. All ground wires and cables shall be copper.
- B. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent. Other bonding clamps or fittings in above ground locations shall be as manufactured by O.A. Co., T & B, Burndy, or approved equivalent.
- C. Ground electrode pipe systems shall be solid copper construction. Ground rods shall be 5/8" minimum diameter, eight feet long, copperweld steel. All ground electrode systems shall be installed in accord with manufacturer's recommendations, U.L. listings, National Electrical and National Electrical Safety Codes.
- D. Bond to Existing Building Services in Existing Building for common ground.

3. INSTALLATION

- A. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard

or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.

- B. All equipment grounding conductors to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment not exceeding No. 8 AWG in size shall be green colored Type "THWN".
- C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.
- D. Resistance to the grounding at the service entrance equipment shall be in accordance with the N.E.C. for style of construction and shall not exceed ten ohms as measured by the described testing method.
- E. All circuits shall have a separate grounding conductor, except as otherwise noted.
- F. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.
- G. Where separately-derived systems are utilized as part of the power distribution network, the neutral leg of the secondary side of generators, transformers, etc., shall be connected to a grounding electrode in accordance with the manufacturer's recommendations.
- H. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.
- I. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermally welded bonding jumper of #500MCM copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.
- J. Grounding connections shall **never** be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as channels and angles.
 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260531 - CABINETS, OUTLET BOXES AND PULL BOXES

1. GENERAL

- A. This section of the specifications covers all electrical cabinets, outlet boxes and pull boxes.
- B. Continuous runs of conduit shall have properly sized pull boxes at least each eighty-five feet of run, or as near as possible to that limit.

2. MATERIALS & INSTALLATION

A. Cabinets, Outlet and Pull Boxes:

- (1) Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. Boxes assembled with sheet metal screws will not be accepted. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.
- (2) All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Outdoor cabinets shall be hinged cover with pad locking provisions. Fronts for panelboards shall be as specified for panelboards.
- (3) Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers. Those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2 x safety factor for the anticipated fixture weight.
- (4) Special size concealed outlet boxes for clocks, speakers, alarms, panels, etc., shall be provided by the manufacturer of the equipment.
- (5) Floor outlet boxes shall be as specified in Section 262726, fully adjustable unless noted or specified otherwise.
- (6) Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

Wall Switches, Control Stations	3'-10"
Convenience Outlets	1'-6"
Convenience Outlets - Above Counters	Bottom at 4" above top of backsplash
T.V. Outlets	1'-6"
T.V. Outlets - At Wall Brackets	Refer to Plans
Desk Telephones.....	1'-6"

Weatherproof Outlets	2'-2"
Disconnects, Branch Panelboards	5'-0" max. to centerline
Fire Alarm Manual Stations	3'-10"
Fire Alarm Audio and/or Visual Units	80" AFF to bottom of device or 6" below ceiling, whichever is lower.

(7) The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings, with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.

(8) Boxes installed in fire rated assemblies shall not compromise the rating of the assembly. The Contractor is responsible for identifying assembly ratings and construction requirements prior to rough-in.

- a. Listed single and double gang metallic outlet and switch boxes with metallic or nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with rating not exceeding 2 h. The boxes shall be fastened to the studs with the openings in the wallboard facing cut so that the clearance between the boxes and the wallboard do not exceed 1/8 in. The boxes shall be installed so that the surface area of individual boxes do not exceed 16 sq in, and the aggregate surface area of the boxes do not exceed 100 sq in per 100 sq ft of wall surface unless approved alternate protection materials are used.
- b. Boxes located on opposite sides of walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between the boxes may be reduced when listed Wall Opening Protective Materials are installed according to the requirements of their Classification.
- c. Boxes installed on opposite sides of walls or partitions of staggered stud construction shall have listed Wall Opening Protective Materials installed with the boxes in accordance with Classification requirements for the protective materials.
- d. All installation shall be done in accordance with AHJ requirements.

(9) All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.

B. Cabinets, outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight, vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved equivalent.

- (1) NEMA 1 or 1A cabinets, outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.
- (2) Outlet boxes for switches, receptacles, telephone, etc., concealed in walls shall be galvanized steel, 2" X 4" X 2" with plaster cover for the number of devices as required. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls, unless noted otherwise.
- (3) Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. Do Not Split The Mortar Joint.
- (4) Boxes for more than two devices shall be for the number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.
- (5) Outlets provided shall have only the holes necessary to accommodate the conduit at the point of installation and shall be rigidly secure in position. Boxes with knockouts removed and openings not used shall be replaced or be provided with a listed knockout closure.
- (6) Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

END OF SECTION 260531

SECTION 260533 - RACEWAYS & FITTINGS

1. GENERAL

- A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.
- B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 that implies or refers to electrical raceways specified therein.
- C. The types of raceways specified in this section include the following:
 - (1) Steel electrical metallic tubing. (E.M.T.)
 - (2) Rigid galvanized steel conduit. (G.R.S.)
 - (3) Intermediate metal conduit (I.M.C.).
 - (4) Rigid aluminum conduit.
 - (5) Flexible metal conduit (aluminum or steel)
 - (6) Liquid - tight flexible metal conduit.
 - (7) Rigid nonmetallic conduit.
 - (8) Cable tray or cable trough.
- D. All raceways, as listed in 1C. above and otherwise specified herein shall be provided in compliance with latest editions of all applicable U.L., NEMA, N.E.C. and A.N.S.I. standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.
- E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all A.C.I. standards and the equipment manufacturer's recommendations for such work.
- F. P.V.C. or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.
- G. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.
- H. Minimum size of conduit shall be 3/4" trade size. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.
- I. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

- J. MC cable may be used for all interior concealed receptacle and lighting circuits. It may not be used in exposed areas or within CMU walls. MC cable may not be used for HVAC and plumbing circuits.

2. MATERIALS

A. STEEL ELECTRICAL METALLIC TUBING

- (1) Electrical metallic tubing, (E.M.T.) of corrosion-resistant steel construction shall be permitted for concealed installation in dry interior locations. Electrical metallic tubing shall not be installed in concrete slabs or where exposed to physical damage. Electrical metallic tubing shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer.

B. RIGID GALVANIZED STEEL CONDUIT

- (1) Rigid galvanized steel conduit shall be used where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground P.V.C. conduits, or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings.

- (2) Rigid galvanized steel conduit shall be used for all building interior power wiring or cables of over 600 Volts.

C. INTERMEDIATE METAL CONDUIT

- (1) Unless otherwise indicated on the drawings, intermediate metal conduit (I.M.C.) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.

D. RIGID ALUMINUM CONDUIT

- (1) Rigid aluminum conduit, shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel. Rigid aluminum conduit shall always be used for power wiring greater than 5 KVA and higher than 60 Hz frequency.

E. FLEXIBLE METAL CONDUIT

- (1) Flexible conduit shall be used where permitted by NEC. It may be constructed of aluminum or steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment grounding conductor or bonding jumper shall be used at all

flexible conduit installations. Maximum permitted length of flexible metal conduit shall be 72", as for light fixture whips unless approved in writing by Engineer.

F. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- (1) Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof.

G. RIGID NON-METALLIC CONDUIT

- (1) Rigid non-metallic conduit shall be constructed of P.V.C, nominally schedule 40 weight, except where encased in concrete, where it may be "EB" type. If installation will enclose utility company provided conductors, verify exact type required and install in accord with their standards, if more stringent than this specification.
- (2) Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid nonmetallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.
- (3) Where rigid non-metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab. Transition may then be made to E.M.T or other approved conduit for remainder of run.
- (4) Flexible nonmetallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.
- (5) Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.

H. OPEN WIRE MESH CABLETRAY

- (1) Section includes continuous, rigid, welded steel wire mesh cable management system.
- (2) References
 - a. ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.

- c. ASTM B 633 - Electrodeposited Coatings of Zinc on Iron and Steel.

(3) Design Requirements

- a. Maximum Deflection Between Supports: $L/240$.

(4) Submittals

- a. Product Data: Submit manufacturer's product data, including UL classification.
- b. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.
- c. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9002 quality certified.

(5) Delivery, Storage and Handling

- a. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- b. Storage: Store materials in a dry area indoors, protected from damage, and in accordance with manufacturer's instructions.
- c. Handling: Protect materials and finishes during handling and installation to prevent damage.

(6) Manufacturer

- a. Cablofil, Inc., 8319 State Route 4, Mascoutah, IL, 62258. Phone (618) 566-3230. Toll Free (800) 658-4641. Fax (618) 566-3250. www.cablofil.com, or approved equivalent. Part numbers included in this section are not meant to restrict truly equivalent manufacturers.

(7) Open Wire Mesh Cabletray System

- a. Description: Continuous, rigid, welded steel wire mesh cable management system.
 - 1) Mesh System: Permitting continuous ventilation of cables and maximum dissipation of heat.
 - 2) Safety Edge: Continuous safety edge T-welded wire lip.
 - 3) Wire Mesh: Welded at all intersections.
- b. UL Classification: Straight sections -Refer to drawings for sizes.

- c. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
- d. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.
 - 1) Hot-Dip Galvanizing: ASTM A 123. (Only in exterior, wet or corrosive locations)
 - 2) Flat Black: Powder painted surface treatment using ASA 61 black polyester coating. (In indoor dry locations)
- e. Nominal Dimensions:
 - 1) Nominal Mesh: 2 x 4 inches.
 - 2) Nominal Straight Section Lengths: 80 inches and 118 inches.
 - 3) Width: Refer to the drawings.
 - 4) Depth: Four inches in depth for all but 6" wide, which shall be 2" depth.
 - 5) Wire Diameter: Nominal .177 inch, minimum.
- f. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.
- g. Support System: Standard.
 - 1) Wall Installation: CS Bracket. Maximum tray width of 12 inches (300 mm).
 - 2) Trapeze Mounting to Ceilings: CS Profile. Maximum tray width of 18 inches (450 mm).
 - 3) Ceiling Installation: CSC Bracket. Maximum tray width of 12 inches (300 mm).
 - 4) Fasteners: As required by tray widths. To be furnished by manufacturer.
- h. Hardware: Hardware, including splice connectors, grounding fittings and support components to be furnished by the manufacturer.
- i. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.

(8) Examination

- a. Examine areas to receive cable management system. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

(9) Installation

- a. Install open wire mesh cabletray system at locations indicated on the drawings and in accordance with manufacturer's instructions.
- b. Load Span Criteria: Install open wire mesh cabletray system in accordance with span load criteria of $L/240$.
- c. Cutting:
 - 1) Cut wires in accordance with manufacturer's instructions.
 - 2) Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
 - 3) Cut each wire with 1 clean cut to eliminate grinding or touch-up.
- d. Install open wire mesh cabletray system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
- e. Coordinate with other trades to provide as straight and accessible runs as possible. Not all offsets are shown on drawings, but Contractor shall make accessible offsets as required around ductwork, structure, piping or other interferences as required.

I. RACEWAY FITTINGS

- (1) Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment.
- (2) Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.
- (3) Expansion fittings shall be provided at all locations where conduits or other raceways cross over expansion joints. Provide copper ground bonding jumpers across expansion fittings.
- (4) Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface

mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.

- (5) Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and No. 14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level.
- (6) Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
- (7) Fittings for E.M.T. conduit shall be of the compression type. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction.
- (8) Indentation or die-cast fittings shall not be permitted in any raceway system.
- (9) All conduit fittings shall be securely tightened. All threaded fittings shall be engaged seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.

3. INSTALLATION

- A. This Contractor shall lay out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall as a minimum conform to the National Electrical Code, unless larger size is indicated on the Contract Drawings.
- B. No conduit larger shall be installed in poured concrete slabs except with permission of the structural engineer. All other shall be held below slab. Conduit shall be held at least 6" from flues or hot water pipes.
- C. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart.
- D. Conduit shall be installed in such a manner so as to insure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.
- E. Junction boxes shall be installed so that conduit runs will not exceed 85', as shown on the Contract Drawings.

- F. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".
- G. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.
- H. At least two 1 inch and four 3/4 inch conduits shall be stubbed from flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.
- I. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the N.E.C., and NECA "Standard of Installation", complying with recognized industry practices.
- J. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.
- K. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure or route through joists webbing wherever possible, to maximize available space and not restrict other trades.
- L. Complete installation of electrical raceways before starting installation of cables or wires within raceways.
- M. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement (where specifically called out to be concrete encased) or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply.
- N. All raceways shall be installed to maintain a minimum of 4" clearance below roof decking.

4. SPECIALTIES

- A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.
- B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the N.E.C. and other applicable codes.
- C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be

equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

- D. All pulling lines left in open conduit systems shall be non-metallic, left securely tied off at each end.
- E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

END OF SECTION 260533

SECTION 260544 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

- A. Each Contractor's attention is directed to Section 260501, General Provisions, Electrical and all other contract documents as they may apply to his work.
- B. Each Contractor shall include all excavating, filling, grading and related items required to complete his work as shown on the drawings and specified herein.
- C. Electrical distribution lines and underground telephone or TV cables shall, in no case, be placed in the same trench with sanitary, storm, domestic or fire protection water lines. Phone cable may, at the Contractor's option, and if acceptable to both utility companies, be placed in a common trench with power lines as long as 8" of earth separation is maintained. T.V. cable shall, in all cases, be placed in a separate trench with two feet separation from electrical power lines.
- D. Depths of bury shall be as indicated on the drawings.

2. SUBSURFACE DATA

- A. Subsurface investigations have been made and the results shown on the drawings. The information was obtained primarily for use in preparing foundation design. Each Contractor may draw his own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time investigations were made. No claim for extra compensation, or for extension of time, will be allowed on account of subsurface conditions inconsistent with the data shown.
- B. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating.

3. BENCH MARKS AND MONUMENTS

- A. Maintain carefully all bench marks, monuments and other referenced points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

- A. Each Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation for his work.
- B. Excavate trenches to sufficient width and depth for proper installation of the work and where required, smooth the bottom on the trench with hand tools.

- C. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Architect. Any damage to existing structures, exterior services or rock intended for bearing, shall be corrected at the responsible Contractor's expense.
- D. Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Pumping or bailing water from this Contractor's trenches, which is required during construction shall be accomplished at his expense.
- E. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, etc. Each Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage, or any other damage incurred in the course of excavation, shall be borne by the responsible Contractor.

5. BACKFILL

- A. Backfill shall be accomplished with clean debris free earth and the new earth tamped at 12" intervals so as to avoid earth sinks along the trench. The responsible Contractor will be required to return to the project and fill any sunken areas along the route of his work.
- B. Backfill trenches only after conduit and cable have been inspected, tested, and locations of pipe lines have been recorded on "as-built" drawings.
- C. The backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.
- D. The backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

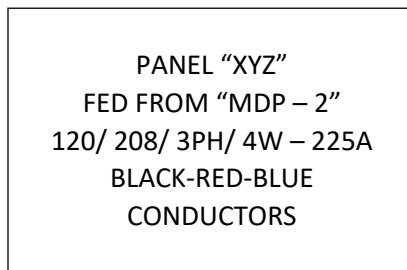
END OF SECTION 260544

SECTION 260553 - IDENTIFICATIONS

1. GENERAL

- A. Equipment, disconnect switches, motor starters, pushbutton stations, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" white lamacoid plate (or equivalent) with black letters 1/4" high.
- B. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc., controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic card holders in each panel. The Contractor shall be required to demonstrate the accuracy of the panel directory for a random sampling of circuits in each panelboard as directed in the field by the Engineer with corrections made immediately so it is imperative that care be taken during installation to insure 100% accurate directories.
- C. All circuit breakers and disconnects serving fire alarm equipment shall be painted red and clearly labeled as Fire Alarm Circuits.
- D. Branch circuit panelboards and switch gear shall be provided with a white lamacoid plastic plate with 1/2" black letters for panel designation and 1/4" black letters showing voltage and feeder information. Branch circuit switches shall be designated as to function. Panelboard and switchgear labels shall indicate the source they are fed from, and the circuit number at that source. Panelboards shall also indicate color coding of the branch circuit phase conductors supplied. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings.

EXAMPLE



- E. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method. Provide RED plates for all since all on generator.
- F. The building service disconnect(s) shall be marked with the maximum available fault current available at that location in accordance with NEC Article 110. If a fault current study is not required by this contract, the Contractor shall obtain fault current availability data from the utility company. This requirement applies to both new and existing services if any distribution equipment is changed.

END OF SECTION 260553

SECTION 260573 - ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All services, materials and installation shall comply with the owners' construction standards. Special attention shall be given to Divisions 02, 16 and 17. In the event of a conflict between these standards and the Contract Documents the most stringent requirement shall be met.
- C. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.
- D. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, arc flash and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
- B. Electrical Studies shall be performed by the Low-Voltage Switchboard manufacturer. All Electrical Studies required by this specification shall be completed within five (5) weeks from award of project. The Electrical Contractor shall provide all required data to Low-Voltage Switchboard manufacturer within one (1) week and the manufacturer will have four (4) weeks to complete the studies.
- C. A licensed professional engineer employee of the Low-Voltage Switchboard manufacturer shall provide electrical power system studies for the project using the latest version of one of the approved software packages. The software model files shall be submitted with the report. The analysis shall follow the latest IEEE 1584 guidelines. An example report will be provided by the university upon request.
- D. Studies specified herein must be submitted and approved prior to release of any affected equipment. Revisions to equipment or devices necessary to meet study recommendations shall be at the Manufacturer's expense.
- E. All adjustments and settings recommended by these studies shall be made prior to any testing.
- F. The analysis shall be submitted to the engineer of record prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
- E. Owners Record Copy: The as-built software model and all electronic files are to be provided to the owner at project closeout. Electronic files are to be compatible with the latest version of SKM software. The owner shall receive rights to use and/or modify the electronic files and data for operations planning, maintenance and modification of their electrical system.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

1.5 Commissioning

- A. This section specifies a system or a component of a system being commissioned as defined in Section 019113 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 019113 Commissioning for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Software utilized shall be capable of converting all data to SKM formatting. Subject to compliance with requirements, provide products by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.

- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated, including arc-reduction features where applicable.

- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
- B. Data shall be obtained for the power sources (utility system and generators), impedance components (transformers, cables and busway), overcurrent protective devices (fuses, circuit breakers and relays) and other relevant equipment such as automatic transfer switches. Cable data (length, quantity per phase, size and type) shall be provided by the electrical contractor. Assumptions should only be used when the actual data is not available and the assumptions should be clearly listed in the report. Assumptions shall be kept to a minimum.
- C. A one-line diagram shall be provided as part of the analysis and shall clearly identify individual equipment buses, bus numbers used in the analysis, cable information (length, quantity per phase, size and type), overcurrent device information (manufacturer, type and size), transformers, motors, transfer switches, generators, etc.
- D. The one line and analysis shall use a numbering scheme where each bus begins with a three digit number followed by a description (e.g., 102 MDPA or 103 ELEV DISC) and each connected circuit breaker or fuse shall have a corresponding designation (e.g., 102-1 MAIN CB, 102-2 ELEVATOR FDR or 103-1 ELEV DISC CB).

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus
 2. Medium-voltage switch and transformers
 3. Distribution panelboards
 4. Branch circuit panelboards
 5. Variable Frequency Drives
 6. Motor Control Centers
 7. Company switches
 8. Fused and non-fused disconnects
 9. Low-voltage transformers
 10. Individual circuit breakers
 11. Automatic transfer switches
 12. Generator
 13. Combination starter/disconnects
- B. Study electrical distribution system from normal and alternate emergency power sources throughout electrical distribution system for Project, using approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10
 - b. ANSI C57.12.22
 - c. ANSI C57.12.40
 - d. IEEE C57.12.00
 - e. IEEE C57.96
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
 - 4. Circuit Breakers: IEEE c37.13.
- E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
 - 1. For overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- G. A table shall be included which lists the calculated short-circuit currents (rms symmetrical three phase), equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment at each bus.
- H. Any inadequacies shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.

- b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.
- H. A table shall be included which lists the recommended settings of each circuit breaker and relay.
- I. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
- J. Deficiencies in protection and/or coordination shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

- K. The electrical engineer that performed the study shall be responsible to set the circuit breakers according to the analysis once the report has been approved by the engineer of record.

3.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The analysis shall consider multiple possible utility scenarios as well as multiple system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations. Where manually activated arc energy reduction means are utilized, the analysis shall calculate energy available downstream for normal operation and for maintenance mode operation.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system. This includes all switchboards, switchgear, motor-control centers, panelboards, busway and splitters.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
 - J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
 - K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
 - L. Incident energy and flash protection boundary calculations
 - 1. Arcing fault magnitude
 - 2. Protective device clearing time
 - 3. Duration of arc
 - 4. Arc flash boundary
 - 5. Working distance
 - 6. Incident energy
 - 7. Hazard Risk Category
 - 8. Recommendation for arc flash energy reduction
 - M. The Arc Flash Hazard Analysis shall include recommendations for reducing Arc Flash Incident Energy (AFIE) levels and enhancing worker safety.
 - N. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location: bus name, protective device name, bus voltage, bolted fault, arcing fault, trip/delay time, equipment type, working distance, arc flash boundary, incident energy and protective clothing category.
- 3.6 ARC FLASH WARNING LABELS
- A. Arc flash labels shall be furnished and installed by the contractor of the Arc Flash Hazard Analysis.
 - B. The labels shall be 4 inches high by 6 inches wide and printed on a Brady THTEL-25-483-1-WA label type or similar. The arc flash label shall be as required by NFPA 70E or as required by the owner's standards.
 - C. After labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- 3.7 Labels shall be machine printed, with no field markings.
- 3.8 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. Provide one arc flash label for all electrical equipment including:
- A. For each 208 volt panelboard, one arc flash label shall be provided.
 - B. For each 208 volt distribution panelboard, one arc flash label shall be provided.
 - C. For each low-voltage switchboard, one arc flash label shall be provided.

D. For each fused or non-fused disconnect switch, one arc flash label shall be provided.

END OF SECTION 260573

SECTION 262400 - ELECTRICAL DISTRIBUTION EQUIPMENT

1. GENERAL

- A. All electrical distribution equipment shall be dead front UL listed for the purpose and application. All equipment shall meet or exceed all applicable requirements of the National Electrical Code (N.E.C.). Any device or component, i.e., switchboard, panel, breaker, switch, etc., used as service entrance equipment, shall be listed for use at 100% of the rated capacity.

2. BRANCH PANELBOARDS

- A. This section covers lighting and power panelboards (refer to schedules, notes on Drawings and the Electrical One-Line Diagram, of the Contract Drawings).
- B. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.
- C. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, plug-in circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Locks shall all be keyed alike. Each door shall have a directory card inside, covered with a plastic shield, filled in with black india ink or typewritten with circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner -- not numbers on Contract Documents.

Special Note: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.

- D. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings.
- E. Circuit breakers for 120/208 volt systems shall be of 10,000 A.I.C. RMS symmetrical rating unless otherwise indicated on the Contract Drawings.
- F. All main bus and connections thereto in branch panelboards shall be copper. All bus bars shall extend full length of panelboards.
- G. All circuit breakers used to switch lights shall be SWD (switching duty) rated and U.L. listed for the purpose.
- H. Where required by the National Electrical Code, provide branch arc-fault circuit interrupters (A.F.C.I.'s) in branch panelboards, whether indicated on the panel schedule or not. They shall be U.L. listed, latest edition.

- I. Where branch circuit breakers feed hermetically, sealed compressor for cooling or refrigeration equipment, provide U.L. listed H.A.C.R.-style circuit breakers.
- J. Where branch circuit breakers are indicated or required to be ground-fault circuit-interrupting type (G.F.C.I.), they shall have test and reset buttons and be U.L. listed, latest edition. Do not share neutrals with other circuits.
- K. Where branch circuit breakers are feeding H.I.D. (high-intensity-discharge) loads, they shall be rated and listed for such loads. Provide proper circuit breaker whether indicated on panel schedules or not.
- L. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- M. Panels shall be Siemens to Match Existing.
- N. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

3. INSTALLATION INSTRUCTIONS

- A. Panelboards with circuit breakers installed before the building has been finished and cleaned shall be masked.
- B. All dust and debris shall be removed from the panels before they are energized and placed in service.
- C. All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.
- D. All service equipment shall be marked with the maximum available fault current and the date of the calculation. This information shall be obtained in writing from the serving utility. Provide label adjacent to the service disconnecting means. Document action of the fault current shall be included in the operation and maintenance manual. This labeling shall be provided for all new service installations, service upgrades, and any project that adds or replaces distribution panels or branch panel boards.

4. SAFETY SWITCHES

- A. Provide heavy duty safety switches as a final disconnecting means as required by NEC and/or as indicated on the Contract Drawings.
- B. All safety switches shall be NEMA Type 1, NEMA 3R, NEMA 4 stainless steel, NEMA 12, or as required by the operating environment, Heavy Duty Type HD, UL listed.

- C. All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.
- D. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.
- E. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.
- F. Arc Flash Hazard warning labels shall be affixed to all switches in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- G. Switches shall be as manufactured by Siemens to match existing.

5. CONTACTORS

A. General

- (1) Contactors shall be continuously rated at the specified amperes per pole for all types of ballast and tungsten lighting, resistance and motor load. Contactors shall have totally enclosed, double-break silver-cadmium-oxide power contacts. Auxiliary arcing contacts will not be acceptable. Contact inspection and replacement shall be possible without disturbing line or load wiring. Contactors shall have straight-through wiring with all terminals clearly marked. Contactors shall have a gasketed NEMA Type 1 (NEMA 12 for electrically-held) enclosure, unless otherwise noted or required.
- (2) Contactors shall be approved per UL 508 and/or CSA, and be designed in accordance with NEMA Standards. They shall be industrial-duty rated for applications to 600 volts maximum. I.E.C.-style contactors are not acceptable.
- (3) Contactors shall have provisions for factory or field addition of:
 - a. Four N.O. or N.C. auxiliary contacts rated 6 amperes continuous at 600 volts.
 - b. Single or double circuit, N.O. or N.C., 30 or 60 ampere 600 volt power-pole adder.
 - c. Control-circuit fuse holder, one or two fuses.
 - d. 0.2-60 second adjustable interval timer attachment, if so indicated on plans.

- e. Transient-suppression module for coil control circuit. Coil control to be 120 volts. Provide circuit or step-down transformer.

B. Electrically Held Lighting Contactors

- (1) Contactor coils shall be continuously rated and encapsulated, 120 volt rated. Enclosures shall be NEMA 12, to minimize noise transmission.

C. Mechanically Held Lighting Contactors

- (1) Coil-clearing contacts shall be supplied so that the contactor coils shall be energized only during the instance of operation. Both latch and unlatch coils shall be encapsulated. Coils shall be rated for 120 volt operation.
- (2) Lighting contactors shall be Square D Class 8903 or equivalent by G.E., Siemens, Eaton/Cutler-Hammer or Allen-Bradley.

END OF SECTION 262400

SECTION 262726 - WIRING DEVICES AND PLATES

1. GENERAL

- A. This section of the specifications includes wiring devices, cover plates, weatherproof and dust-tight closures, communications devices and floor outlets.
- B. Wiring devices are listed by manufacturer and catalog numbers to establish the quality and type required. Equivalent devices of other manufacturers will be acceptable with prior approval of the Engineer. Submit cutsheets and/or samples of each type ten days prior to bid date for review and written approval to bid. Insofar as possible, standard application or special application devices shall be by one manufacturer.

2. MATERIALS

TYPE	RATING	CONFIGURATION	COLOR	VENDOR - CAT. #
RECEPTACLE - DUPLEX COMMERCIAL GRADE	125V, 20A	NEMA 5-20R	!	HUBBELL CR5362* GE 5362*
	125V, 15A	NEMA 5-15R	!	LEVITON 5362* HUBBELL CR5262** GE 5262** LEVITON 5262**
* USE WHEN ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHEN ON DEDICATED 15A CKT., OR WHEN MORE THAN ONE RECEPTACLE ON A CIRCUIT				
RECEPTACLE - DUPLEX G.F.I. (SHALL MEET U.L. 943 STANDARD)	125V, 20A	NEMA 5-20R	!	HUBBELL GFR5352A
RECEPTACLE - SIMPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL 5361
RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER-RESISTANT SCREWS)	125V, 20A	NEMA 5-20R	!	HUBBELL HBL-8300- SG
SWITCH, SINGLE POLE	120V, 20A	SPST	!	HUBBELL HBL-1221 GE 5951 LEVITON 1221
NOTES:				
1. PROVIDE MATCHING CAP (PLUG) FOR ALL RECEPTACLES 30 AMP RATED AND ABOVE AS REQUIRED FOR EQUIPMENT.				

2. ALL RECEPTACLES SHALL BE BACK OR SIDE-WIRED, CLAMPING TYPE
3. ALL RECEPTACLES INSTALLED IN DAMP OR WET LOCATIONS SHALL BE UL LISTED WEATHER RESISTANT TYPE.
- ! SEE ARTICLE 3, COLOR.

A. Small Motor Control Switches:

- (1) For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 volts, provide snap-type, H.P. rated motor starter switch with thermal overloads. Overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere. All manual starters in finished areas shall be in flush-mounted enclosures.

3. COLOR

- A. Color of devices shall be as selected by the architect. Samples (devices, plates or both) may be required to be submitted with other architectural color items by the Contractor. The Contractor shall coordinate any such submission required with other trades, the Prime Contractor or as needed.
- B. Where surface finishes next to the devices vary in color or shade throughout the project, the Contractor may be required to provide lighter or darker plates and devices to more closely match wall finishes. These variations are considered to be included in the original contract for construction.

4. PLATES AND COVERS

- A. Unless otherwise specified or noted, all wiring device plates and covers shall be smooth thermoplastic, Hubbell "P" Series or equivalent G.E. or Leviton. Color shall match device unless otherwise indicated.
- B. All kitchen, area plates shall be bright finish 302 stainless steel.
- C. Cover plates shall be of one manufacturer insofar as possible.
- D. Weatherproof plates for G.F.C.I. receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, U.L. listed for wet location use, cover closed. Vertical mounting - Hubbell WP26M, horizontal mounting - Hubbell WP26MH (die-cast zinc) or equivalent Leviton or G.E.

- E. Weatherproof switch plates for toggle-handle switches shall be clear silicone rubber, for standard outlet boxes. Hubbell 1795 or equivalent G.E. or Leviton.

5. INSTALLATION

- A. All wiring devices in dusty areas, exposed to weather and moisture shall be installed in Type "FS" or similar conduit fittings having mounting hubs, with appropriate cover plates.
- B. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed.
- C. Provide G.F.C.I. duplex feed-thru style receptacles in accordance with new U.L. Standard 943 where indicated or required by the National Electrical Code, whether specifically called out or not. When a G.F.C.I. receptacle is on a circuit with other non-G.F.C.I. receptacles, it shall always be placed at the homerun point of the circuit and shall be wired to ground-fault interrupt protect the downstream outlets on that circuit unless specifically indicated to the contrary. Provide a "G.F.C.I. protected" label on each downstream outlet.
- D. GFCI devices shall be installed in a "readily accessible" location per NEC requirements. GFCI protected outlets required by plans or code shall be fed by a GFCI breaker or upstream GFCI device if they are not readily accessible.
- E. Where surge suppression outlets are provided, they shall be ANSI Category "A" style. They shall be installed as dedicated-circuit outlets or where indicated with multiple outlets on a circuit, they shall be placed at the homerun point of that circuit and feed-thru wired to protect the downstream outlets on that circuit.
- F. All receptacles shall be installed with ground prong at **top** position.
- G. All outlets not provided with wiring devices shall be closed with a blank plate matching other plates in the area.

END OF SECTION 262726

SECTION 263213 - EMERGENCY GENERATOR – INCLUDE AS PART OF ALERNATE.

1. STANDBY GENERATOR SET

INTENT OF SPECIFICATIONS

The Contractor shall secure for the purchaser a standby diesel engine-generator set of the latest commercial type and design as specified herein.

2. GENERAL

- A. All materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacturer and of highest grade.
- B. The engine generator set shall contain components as manufactured by Caterpillar, Olympian, Detroit Diesel, Kohler, Generac, Onan, Marathon, or approved equivalent.
- C. Equipment furnished under this section shall be guaranteed against defective parts or workmanship under terms of the manufacturer's and dealer's standard warranty, of not less than five years. The Contractor shall unconditionally guarantee the installation for a period of one year from the date of final acceptance.
- D. The generator set shall receive the manufacturer's standard factory load testing. Prior to acceptance of the installation, equipment shall be tested to show it is free of any defects, will start automatically and shall be subjected to full building load for a period not less than four hours.
- E. On completion of the installation, start-up shall be performed by a factory trained dealer service representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit. Maintenance and operation procedures shall be explained to the satisfaction of the operating personnel. A full set of brochures shall be provided and stored at the generator installation.
- F. The generator set supplier must have the ability, from within his own operation, to service the engine, generator, automatic transfer switch and all auxiliary components, regardless of how major the repair. He must have local service available from within his own organization not more than five hours driving time from the installation site.

3. GENERATOR SET CHARACTERISTICS

Standby KW	200 KW
Standby KVA	250 KVA
Engine Rating Conditions	29.38 HG and 85°F
Power Factor at Specified KW	0.8%
Frequency	60 HZ
Maximum Ambient Temperature Rating	110°F
Minimum Ambient Temperature Rating – Outdoor	Minus 20°F
Minimum Ambient Temperature Rating – Indoor	30°F

All Ratings Shall Be Certified at 1800 RPM for Engine and Generator

- A. The specified standby KW shall be for continuous electrical service during interruption of the normal utility source.
- B. The ratings must be substantiated by manufacturer's standard published data. Special ratings or maximum ratings are not acceptable. The specified rating shall be the net KW available after deducting all engine driven accessories.
- C. The generator output voltage shall be 120/208/3 phase-4 wire.
- D. Gear reduction devices coupling the engine and generator shall not be used. The engine shall be directly coupled to the generator, in a 1:1 ratio.

4. ENGINE

- A. The engine shall be water cooled inline or vee form, two or four stroke compression ignition diesel. It shall meet these specifications when operating on No. 2 domestic burner oil. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil and intake air filters, lube oil coolers, fuel priming pump, fuel transfer pump, and water pump
- B. The engine governor shall maintain frequency regulation not to exceed 5% (3Hz) from no load to full rated load.
- C. The engine generator unit shall be mounted on a structural steel sub-base and shall be provided with suitable vibration isolators between generator set frame and the base mounting rails. The generator set shall be installed on a minimum 4" high concrete pad that is crowned in the center to permit full drainage from beneath the unit. It shall be securely fastened to the pad in a manner as approved by the generator set manufacturer. The concrete pad shall extend at least six inches beyond the generator outline or housing in all directions. For outdoor installations, the concrete pad shall extend 6" beyond the housing at access panels opening to control panels or equipment points requiring service.
- D. Safety Devices - Safety shutoffs for high coolant temperature, low coolant levels, low oil pressure, overspeed, and engine overcrank shall be provided.
- E. Lube oil shall be premium quality, furnished by the generator set supplier, as recommended by the engine manufacturer.

5. GENERATOR

- A. The generator (AC Alternator) shall be a 3 phase, 60 Hz, single bearing, synchronous type with brushed exciter and be built to NEMA Standards. Class "F" insulation shall be used on the stator and rotor, and both shall be further protected with 100% epoxy impregnation and an overcoat of resilient insulating material to reduce possible fungus and/or abrasion deterioration.

- B. A generator mounted regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be $\pm 2\%$ from no load to full rated load. Readily accessible voltage level controls shall be provided. Voltage level adjustment shall be a minimum of $\pm 5\%$.

6. COOLING SYSTEM

- A. An engine mounted radiator with a blower type fan shall be sized to maintain full rated load safe operation at 110°F maximum ambient temperature. The radiator shall be equipped for a duct adapter flange. Air flow restriction from the radiator shall not exceed 1/2" water column or the maximum allowable per shop drawings, if less. For units provided without factory enclosure, the Contractor shall provide ductwork with flexible connecting sections between the radiator duct flange and exhaust damper. All sheetmetal work shall be in compliance with the current edition of SMACNA, installed by skilled tradesmen.
- B. The engine cooling system shall be filled with a solution of 50% ethylene glycol and 50% potable water.

7. FUEL SYSTEM

- A. The entire fuel system installation shall be installed in accordance with local, state and other governing regulations. The entire system shall be inspected and approved by the governing authority. The piping system shall be installed by qualified, approved mechanical tradesmen.
- B. Provide a 1000 (nominal) gallon tank, mounted beneath generator for 3 complete days of operation. For units with conduit feed(s) from below, provide conduit stub-up location(s) that will allow rough-in to be wholly within footprint of base rails. Provide fuel level gauge with sensor. Provide accessible, replaceable fuel strainer. Provide a U.L. listed-double wall tank with leak detector and local audible alarm that complies with applicable codes and requirements. This tank is to be provided for 48 hour run time.
- C. Provide an engine mounted fuel filter, fuel transfer pump as needed and heavy-duty flexible fuel connections at engine.
- D. Provide all fuel for testing and leave a full tank for the Owner's use at close of project. Provide the proper amount of cold weather fuel treatment per manufacturer's requirements if installed outdoors.

8. EXHAUST SYSTEM

- A. Provide a side inlet critical type silencer with aluminized coating, including an engine-mounted stainless steel corrugated flexible exhaust element. Use stainless steel hardware to fasten these components together and to the engine block.
- B. For outdoor engine/generator installations with enclosures, the silencer shall be mounted inside the enclosure, on corrosion-resistant brackets. Orient exhaust direction away from structures and air intakes. Turn outlet pipe up to the vertical with a sweeping bend and provide a rain cap.

9. AUTOMATIC STARTING SYSTEM

- A. A 12 or 24 volt DC electric starting system with positive engagement drive shall be furnished.
- B. Fully automatic generator set start/stop controls in the generator control panel shall be provided. Controls shall provide shut down for low oil pressure, high coolant temperature, low coolant level, overspeed, overcrank with one auxiliary convertible contact for activating accessory items. Controls shall include a thirty second single cranking cycle limit with lockout. Provide interconnecting wiring in conduit to remote annunciator (if specified) as required.
- C. A 12 or 24 volt lead acid storage battery set of the heavy duty diesel starting type shall be provided. The battery set shall be of sufficient capacity to provide for 12 minutes total cranking time without recharging, with sufficient amp hour rating to suit the engine selection. A corrosion-resistant battery rack, necessary cables and clamps shall be provided. Provide connection using THWN wiring in conduit to battery charger, as required.
- D. For outdoor installations, provide battery warming pads rated at 120 volts input, in accord with the battery manufacturer's recommendations. Provide normal power 120 volt circuit as required.
- E. A current limiting automatic two rate battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicone diode full wave rectifiers, voltage surge suppressors, DC ammeter, and fused AC input. AC input voltage shall be 120 volts. Provide emergency generator powered circuit as required. Amperage output shall be no less than ten amperes.
- F. A unit mounted thermal circulation type water heater(s) controlled by a thermostatic switch shall be furnished to maintain engine jacket water to 120°F. in an ambient temperature of 0°F. Provide for 120 or 208 volt, single phase operation, per manufacturer's recommendation. Provide normal utility source power circuit as required.

10. GENERATOR CONTROL PANELS

- A. A generator mounted NEMA 3R type vibration isolated dead front control panel constructed of code gauge steel shall be provided.
- B. Control panel shall contain, but not be limited to the following equipment:
 - 1) Voltmeter, analog gauge, 2% accuracy
 - 2) Ammeter, analog gauge, 2% accuracy
 - 3) Voltmeter and Ammeter phase selector switch
 - 4) Frequency meter, analog or vibrating reed type, 2% accuracy
 - 5) Automatic starting controls as specified
 - 6) Panel illuminating lights and test switch

- 7) Voltage level adjustment rheostat
- 8) Engine oil pressure gauge
- 9) Engine water temperature gauge
- 10) Contacts for remote alarms wired to terminal strips
- 11) Fault indicators for low oil pressure, high coolant temperature and low coolant level, overspeed and overcrank
- 12) Multi-position function switch with "Auto", "Manual", "Off/Reset" positions
- 13) Engine running elapsed time meter, cumulative, non-resettable Emergency stop switch, with local audible alarm

C. Digital metering may be substituted for analog style gauges, at the Contractor's option.

11. MAIN LINE CIRCUIT BREAKER

- A. Generator mounted main line molded case circuit breaker of 600 amps shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions.
- B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriter's Laboratories, National Electric Manufacturer's Association and National Electrical Code.
- C. Generator exciter field circuit breakers are unacceptable when utilized for line protection.

12. AUTOMATIC TRANSFER SWITCH

- A. Automatic transfer switch(es) shall be furnished as shown on the drawings and specified below. Switch shall be capable of switching all classes of loads and shall be rated for continuous duty when installed in a non-ventilated enclosure. Enclosures shall conform to UL and NEMA standards.
- B. The transfer switch shall be double throw, inherently interlocked mechanically and electrically, actuated by a single electrical operator which is momentarily energized. The switch shall be capable of transferring successfully in either direction with 70% of rated voltage and shall be mechanically held.
- C. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Mechanical interlock shall be separate from operating mechanism, providing positive interlock in the event of operator failure. Provide mechanism external to cabinet for manual operation of switch.
- D. If any phase of the normal source drops below 70% of rated line voltage, an engine start contact shall close to start the generating plant after the specified time delay. The transfer switch shall transfer to the emergency source after the alternator voltage and frequency have reached 90% of rating. After restoration of normal power on the normal source, retransfer to normal shall occur with delay set at five minutes, adjustable from zero to thirty minutes.

E. As a precondition for approval, all switches, complete with timers, relays and accessories shall be listed by UL under Standard UL 1008 Automatic Transfer Switches and shall be approved for use on emergency power systems per NFPA and all applicable codes.

F. Transfer switch ratings and accessories shall be as follows:

600 amp
208 volts
3 phase
4 wire
60 Hz
3 pole
Wall mounted
Totally enclosed, NEMA 3R
Solid neutral, insulated from enclosure
Ground bar, bonded to enclosure

G. Transfer Switch Accessories:

- (1) Time Delay for engine start on utility failure, factory set at 3 seconds, adjustable 1-60 seconds.
- (2) Adjustable time delay on retransfer to normal (motor driven type - 0 to 30 minutes, set at five minutes, arranged for five minute unloaded running time for standby plant cooldown).
- (3) Close differential relay protection on normal, using 3 phase, 4 wire relays when are factory set for 90% pick-up, 70% dropout. Relays shall be adjustable.
- (4) Test switch to be mounted on cabinet - to provide for load, no-load and off-line, operation of emergency plant and transfer switch.
- (5) Auxiliary contact to close when normal power fails (pilot contact to initiate starting controls on engine).
- (6) Pilot lights for indicating switch in emergency (red) and normal (green) position.
- (7) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on normal).
- (8) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on emergency).
- (9) Enclosures to be NEMA 3R.
- (10) Frequency relay - To prevent transfer to emergency until voltage and frequency of generating plant have reached 90 percent of rating.

- (11) Retransfer phase protection – The switch shall be equipped with an in-phase relay or delayed (programmed) transition feature to prevent out-of-phase switching. All settings shall be adjusted per manufacturer’s recommended practice prior to energizing switch.

13. ANNUNCIATOR PANEL

- A. A fully flush-mounting trim panel shall be provided for remote mounting to give audible and visual warning of fault or alarm conditions in the generator set. The panel shall conform with the requirements of the National Electrical Code, Section 700-12, and the National Fire Protection Association Publication NFPA 99 (NFPA 110 in health care installations). All necessary contacts shall be provided, including low fuel level in the storage tank. Locate as shown on plans or as directed by the Engineer and connect in accordance with shop drawing requirements.

14. WEATHERPROOF ENCLOSURE

- A. Provide a weatherproof, Level 2 sound attenuated corrosion-resistant outdoor housing to enclose the entire generator set. Enclosure shall be provided with tamper-resistant hardware and shall have lockable (keyed alike) access panels for access to all major components.
- B. Enclosure shall be painted a color as approved by the Architect and/or the Engineer, selected from manufacturer's standard colors.
- C. The enclosure shall be the standard product of a manufacturer that is represented by the generator set supplier.

END OF SECTION 263213

SECTION 264313 - SURGE SUPPRESSION SYSTEMS

1. GENERAL

- A. Each Contractor's attention is directed to Section 260501, General Provisions - Electrical and all other contract documents as they may apply to his work.
- B. Each Surge Suppression Unit (transient voltage surge suppressor, or T.V.S.S.) furnished shall meet or exceed U.L. 1449, Second Edition *Revision* (February 2007), with capacity for each basic Category A, B and C, surge rise time of ten microseconds and a surge duration of at least one thousand microseconds.
- C. SPECIAL NOTE: When using a "Meggar" or similar instrument to test conductors in a panelboard or switchboard, disconnect any T.V.S.S. device connected to any combination of those conductors. Failure to do so may damage or destroy the T.V.S.S. device. If any damage occurs as a result of testing to a T.V.S.S. device, the Contractor shall replace the device.

2. SCOPE OF THE WORK

- A. The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein. This work shall include, but is not necessarily limited to:
 - (1) Provision of Surge Suppression Units at certain points in the power distribution network, on telephone, satellite dish leads and cable television service lines as indicated herein or on the drawings.
 - (2) Proper installation of surge suppression unit(s), in accord with shop drawings. Wiring routing, grounding, raceways and all connections shall be in exact accord with manufacturer's recommendations, the National Electrical Code, and any other applicable regulations, local or national, or international.

3. QUALITY ASSURANCE

- A. The manufacturer shall be regularly engaged in production of surge protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than three years.
- B. Comply with NEC and NFPA requirements, as applicable to materials and installation of surge protection components and wiring. Surge protection equipment shall be UL listed and labeled for its intended use. TVSS shall be labeled with 200kA Short Circuit Current Rating (SCCR). Where applicable, equipment shall comply with ANSI standards for such equipment.
- C. SPECIAL NOTE: The physical routing, length and connections of the unit's phase, neutral and ground conductors are critical to the performance of surge suppression units. The Contractor shall carefully observe and comply with the manufacturer's installation requirements.

4. SUBMITTALS

- A. Product Data: Submit manufacturer's data on surge protection systems and components as part of shop drawing submissions. Indicate all capacity ratings, clamp times, maximum capacities, EMI/RFI attenuation data, withstand capabilities, physical construction and listing agency approvals.
- B. Maintenance Data: Submit maintenance instructions for surge suppression system. Include this data in Operation and Maintenance manuals.

5. MATERIALS

A. ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering surge protection components which may be incorporated in the work includes, but are not limited to, the ones listed below. Other manufacturers will be considered if their proposed products are in full compliance with these specification requirements.

Surge Protective Devices:

- Liebert Corporation, Inc
- General Electric Corporation
- Transtector, Inc.
- Advanced Protection Technologies, Inc.
- Square D. Inc.

6. T.V.S.S. MINIMUM REQUIREMENTS

T.V.S.S. minimum requirements shall meet or exceed the following criteria:

A. Minimum surge current capability (single pulse rated) per phase shall be:

(1) Service entrance applications: 200 kA per phase (Category "C")

B. UL 1449 Listed Suppression Voltage Ratings for service entrance shall not exceed the following: (Category "C")

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>MCOV</u>
208Y/120V	400	400	400	150V

(With internal disconnect switch 400V and 800V respectively).

(L-N = Line to neutral)

(L-G = Line to ground)

(N-G = Neutral to ground)
(MCOV = Maximum continuous operating voltage)

7. BUILDING ELECTRICAL SERVICE SURGE PROTECTION SYSTEM COMPONENTS

A. GENERAL

- (1) Provide UL 1449 Second Edition *Revision* (February 2007) listed and labeled lightning and transient surge protection devices, installed where shown on the drawings and in accord with the manufacturer's recommendations.
- (2) The surge protection devices shall be shunt type and polyphase, with the ability to conduct high energy transients from line to ground, line to neutral and neutral to ground. Provide in a NEMA 12 enclosure with hinged or screw cover front panel. Provide internal fusing in modules to protect unit.
- (3) Provide units with EMI/RFI noise attenuation, using 50 ohm insertion loss test: -50 dB at 100 khz, UL 1283 listed, with an insertion ratio of 50:1 using M.I.L. STD 220-A.
- (4) For each surge suppression unit, categories A, B & C, provide unit function status indicators. These indicators shall be mounted in the face of the equipment panel. Provide green L.E.D., illuminated for normal operation, red L.E.D. for trouble/fault or reduction of surge suppression capacity. Provide an audible alarm with silence switch to alarm at unit on malfunction for category "C" units only. Provide a resettable surge counter for each category "C" unit to indicate each suppression operation of the unit.
- (5) Enclosures shall be surface-mounted where panels protected are surface-mounted, flush-mounted for all units in finished areas. Where panels protected are flush-mounted, place surge suppression device above or below panel, aligned and square with panel trim.
- (6) Provide disconnecting means for each surge protection device per the following:

Category "C" Device at Main Service:

60 Ampere, 3 Pole, 600V, S/N, NEMA 1 disconnect. Disconnecting means shall be capable of withstanding the available fault currents. Verify fault current with the Contractor.

- (7) Internal Device Overcurrent Protection (Fusing)
 - a. All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I²t capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. Every suppression component of every mode (including Neutral to Ground) shall also be protected by thermal overtemperature controls. If the rated I²t characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 KA symmetrical fault current with 600 VAC applied.

This overcurrent protection circuit shall be monitored, to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.

B. MAIN SERVICE SURGE SUPPRESSION - CATEGORY "C" UNITS

- (1) Category "C" units shall be installed on the service entrance or building entrance equipment. Units shall be rated 120/208 volts, 3 phase, 4 wire, minimum 200,000 amp (total amps per phase) surge capacity, with less than 5 nanosecond reaction time. Category "C" units installed to protect a switchboard may be built into the switchboard construction if U.L listed for such applications.
- (2) Category "C" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.

C. TELEPHONE AND TELEVISION SURGE SUPPRESSION

- (1) As a part of this section of work, the Contractor shall provide or arrange for the installation of U.L. listed lightning and surge arrestors on the incoming telephone and television service lines, as well as on AM-FM- antenna downloads and the coaxial cables coming into the building from satellite dish antennas and all other types of exterior antennas installed by the Contractor or Owner, where the Contractor installs the coaxial cable for the antenna.
- (2) Arrestors shall be U.L. listed, properly grounded per N.E.C., and shall be located at the service entrance points for each cable installed by a utility company or at the point of building entry for Contractor-installed cables leading in from antennas. Also provide surge arrestors of the proper type for any copper cables that are installed between buildings by the Contractor, if such a condition occurs within the project.
- (3) The Contractor shall arrange for the telephone company to install M-O-V, gas-type or other U.L. listed lightning arrestors on each of their incoming telephone circuits that are terminated for building use.
- (4) Arrestors for coaxial lines shall be rated 25 to 250 MHZ on cable T.V. lines, and 250 MHZ to 1GHZ on satellite dish lead-ins with BNC jacks in/out or as required by antenna connectors.
- (5) Devices as manufactured by Lucent Technologies, Winegard or Liebert Corporation will be acceptable.
- (6) Provide a ground lug for individual surge suppression unit installations, with the recommended ground wire size routed back to the building main electrical ground or ground bar in wiring closet.
- (7) Where multiple surge suppression units are installed, as at service entrance locations, provide a ground bar, copper, with multiple tapped holes and a properly sized ground lead routed back to the building main electrical ground.

8. EXECUTION

A. Installation of Surge Protection Systems:

- (1) Install surge protection systems as indicated and in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA, local prevailing codes and with UL lightning and power surge protection standards to ensure that surge suppression systems comply with requirements.
- (2) Coordinate with other work, including electrical wiring work as necessary to interface installation of units.
- (3) Install conductors with direct, shortest possible phase, neutral and ground paths from all in/out connections, avoiding sharp bends and narrow loops.
- (4) Install surge suppression units as close as practical to equipment they are protecting. Install appropriate units at main electrical service entrance equipment and secondary branch panelboards as indicated.
- (5) Refer to the drawings for installation of individual surge suppression devices to protect branch circuits. Also see Section 262726 for (receptacle type) device requirements. All receptacle type surge suppression units shall be wired as feed-thru type, to protect all downstream outlets on that branch circuit unless otherwise indicated.

9. WARRANTIES

- A. All surge suppression equipment shall be unconditionally warrantied by the Contractor for a period of one year from the date of project substantial completion. Where longer manufacturer's warranties are offered, they shall be made available to the Owner. Note these extended warranties in the Operations and Maintenance Manuals.
- B. Category "C" devices to carry 5 year parts and on site labor unconditional warranty.

END OF SECTION 264313

SECTION 265113 – LED LIGHTING FIXTURES AND LAMPS

1. GENERAL

- A. Furnish and install all lighting fixtures, as herein specified, complete with accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts. All fixtures to be Cooper lighting manufacturer and shall integrate completely with Cooper Trellix Lighting Control System.
- B. All items furnished shall comply with the latest standards applicable such as U.L., NEMA, etc., and shall bear labels accordingly. All fixtures shall be the color specified or as selected by the Architect. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or fingerprints shall be restored to new condition or shall be replaced.
- C. A PDF copy of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data, installation data and, if applicable, air handling data, shall be submitted to the Engineer for written approval 30 days after bid date. (Submission shall be made via the University's online project management system.)
- D. Locate pendant, surface mounted or chain-hung industrial fixtures in mechanical rooms and similar spaces to avoid ductwork and piping. Locate around and between equipment to maximize the available light. Request a layout from the Engineer if uncertain about an installation.
- E. Alternate fixtures may be substituted for types specified by name or catalog number. Proposed substitutions must be submitted to the Engineer ten working days prior to bid date for written approval to bid. This written approval will only be issued in addendum form.
- F. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an unswitched power line and wired in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible with fixture door open, or shall be remotely flush mounted in the ceiling adjacent to the fixture.
- G. Where remote emergency lighting transfer relays are provided, they shall be flush mounted in the ceiling adjacent to a controlled fixture. They shall be connected to an unswitched power line and installed in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible without removing ceiling tiles or access panels.
- H. All reflecting surfaces, glass or plastic lenses, downlighting cones and specular reflectors shall be handled with care during installation to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

- I. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.
- J. Warranty shall start at Final Project Completion.

2. VOLTAGE

- A. All lighting fixtures will be rated 120 volts.

3. LED FIXTURES

LED SOURCES

- A. LED's shall be manufactured by a manufacturer who has produced commercial LEDs for a minimum of five (5) years.
- B. Lumen Output – minimum initial delivered lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-360 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.
- C. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.
- D. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
- E. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable
- F. Light Color/Quality:
 - a) Correlated Color temperature (CCT) range as per specification, between 3000K, 3500K and 4000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
 - b) Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.
 - c) The color rendition index (CRI) shall be 80 or greater
 - d) LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

LED DRIVERS

- A. Driver: Acceptable manufacturer: eldoLED, Sylvania, or Philips that meet or exceed the criteria herein.
- B. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- C. Driver should be UL Recognized under the component program and shall be modular for simple field replacement.

- D. Electrical characteristics: 120 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
- E. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 0.1 percent of rated lumen output with a smooth shut off function unless specifically scheduled otherwise.
- F. Dimming shall be controlled by a 0-10V signal unless specifically scheduled.
- G. Driver shall include ability to provide no light output when the control signal drops below 0.5 V, and shall consume 0.5 watts or less in this standby.
- H. Driver shall be capable of configuring a linear or logarithmic dimming curve.
- I. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range regardless of the controller type
- J. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have: Less than 1 percent flicker index at frequencies below 120 Hz and less than 12 percent flicker index at 120 Hz, and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz
- K. Driver disconnect shall be provided where required to comply with codes.

LED ELECTRICAL

- A. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements.
- B. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A. To reduce false circuit breaker tripping due to turn on inrush, the following statement ensures that electronic dimming driver will meet NEMA inrush recommendations.
- C. Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps² – seconds.
- D. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions
- E. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance.
- F. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

4. LIGHT FIXTURE GENERAL REQUIREMENTS

A. LED Recessed Lighting Fixtures - General Requirements

- (1) The following are minimum requirements for recessed LED fixtures for lay-in grid, gypsum board, plaster and concealed spline ceilings. Surface-mounted LED fixture requirements shall be similar.
- (2) Housings shall be a minimum of 4" depth, premium grade, constructed of a minimum 22 gauge die embossed or stiffened cold rolled pre-treated rust-resistant steel.
- (3) All parts shall be finished with polyester powder or white baked enamel (85% minimum reflectance) painted after fabrication. All wiring shall be type TFN, or THWN and shall be covered by the steel driver cover or wiring channel. Exposed wiring is not acceptable. Connection wiring shall be accessible thru a hinged access plate above driver channel in top of unit.
- (4) The complete light fixture unit shall be UL listed and labeled. Other agency listings may be acceptable with written approval from the Engineer.
- (5) Fixture lens doors shall be reversible, hinged, painted after fabrication, with spring-loaded or other mechanically stable positive action latches.
- (6) Lens shall be as specified for each fixture type. If a specific manufacturer and series number of lens is listed, the substitute shall be of the exact specification (thickness, prism configurations, transparency, efficiency, photometric distribution, hardness, vandal-resistance, etc.). Minimum average thickness of any prismatic lens shall be .125".
- (7) Fixture trim and/or flanges shall conform with ceiling constructions as required. Verify all types prior to submission of shop drawings and indicate any special types on submittals. Fixtures installed in drywall or plaster ceilings to be provided with flange, screed and swing gate anchoring system.
- (8) All fixtures shall be furnished with hold down clips to meet applicable seismic codes, four clips per fixture minimum or the equivalent thereof in the installation trim. Verify thickness of drywall or plaster ceilings prior to submission of shop drawings, to allow for proper trim adjustment.
- (9) Support fixtures with one hanger wire at each end. Hanger wires shall be installed within 15° of plumb, maximum or additional support shall be provided. Wires shall be attached to the fixture body and to the building structure - not to the supports of other work or equipment.
- (10) Each type of lay-in fixture shall be furnished with the proper housing flange or lip to suit the type of lay-in grid(s) being utilized on the project. The Contractor is to verify if narrow or standard grid members are being furnished and provide the proper type of light fixture trim. Indicate any special trims on shop drawing submittals.

B. Industrial and Striplight LED Fixtures - General Requirements

- (1) Units shall have die-formed heavy gauge cold rolled steel channels and die-embossed reflectors.

- (2) Finishes to be coated with a gloss powder paint or baked enamel finish with a minimum 85% reflectance.
- (3) Units to have aligner clips where required for a continuous row appearance. Where continuous rows exceed twelve feet in length, provide a "unistrut" channel or similarly adequate mounting to stiffen and align row.
- (4) Units to have captive latches for all covers and wire guards where specified. Wire guards shall be heavy-duty #14 wire gauge minimum with corrosion-resistant plated or vinyl finish.
- (5) Units to be UL listed.
- (6) Mounting brackets and hanging mechanisms shall be as specified in fixture descriptions, or as required. Allow a generous safety margin with all support systems, as recommended by the manufacturer.

C. Recessed Downlight - General Requirements

- (1) Fixture to have an extruded or die-cast aluminum housing. Retaining mechanism shall provide easy access to LED array and driver box.
- (2) Unit to have a corrosion-resistant steel junction box with hinged access covers and thermal protector.
- (3) Mounting/plaster frame to be heavy gauge steel with finishing trim friction support springs, for the required ceiling thickness. Trim to be of color as selected by the Architect.
- (4) Optical system to consist of a sealed LED module with diffuser.
- (5) Provide telescoping channel bar hangers that adjust vertically and horizontally.
- (6) Fixtures to be UL listed for thru-branch circuit wiring, recessed, and damp locations. Where installed in plaster or drywall or other inaccessible ceiling type, they shall be U.L. listed for bottom access.

D. Exit Lights - General Requirements

- (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Edge-lit clear acrylic panel shall be provided where scheduled. Mountings shall be wall or ceiling, universal type, to suit the installation conditions.
- (2) Provide with stencil face, lettering color red, of sizes in accord with code, or as otherwise specified.

- (3) Provide single or double face as scheduled, indicated on plans or as required by the local authority having jurisdiction. Single face exit lights shall not be readable from the reverse side; acrylic blade style lights shall be furnished with an opaque barrier to block the reverse text image. Adjust installation position if required for clear visibility, in accord with applicable codes.
- (4) Complete unit to be finished in color as selected by the Architect. Provide directional arrows as indicated on plans, as scheduled to suit the means of egress or as required by the local authority having jurisdiction.
- (5) All exit signs shall be long life LED type.
- (6) Where emergency backup battery packs are provided with exit lights, they shall have capacities for continuous operation per applicable codes. They shall have reserve battery capacity to operate remote lamps where indicated.

5. LIGHTING FIXTURE SCHEDULE

- A. Refer to the contract drawings for Lighting Fixture Schedule

6. CONTROLS

- A. Refer to the contract drawings for lighting controls information.

END OF SECTION 265113