

2. Automatically opens the gate when platform arrives at a landing. Will also open at landing by pressing call button.
3. ADA Compliant and obstruction sensitive.
4. Low voltage, 24 VDC with all wiring concealed.

G. Lift Components:

1. Machine Tower: Custom aluminum extrusion.
2. Base Frame: Structural steel.
3. Platform Side Wall Panels: 16 gauge (1.5 mm) galvanized steel sheet.
4. Platform Access Ramp: 12 gauge (2.5 mm) galvanized steel plates; slip resistant surfaces.
5. Side Guard Panels: 42-1/8 inches (1070 mm) high mounted on platform.

H. Base Mounting at Lower Landing:

1. Pit Mount: Lift to be mounted in pit with dimensions to meet manufacturers requirements for the platform size specified. Pit construction shall be in accordance to Section 03300

I. Leadscrew Drive:

1. Drive Type: Self-lubricating acme screw drive.
2. Emergency Operation: Manual handwheel device to raise or lower platform.
3. Safety Devices:
 - a. Integral safety nut assembly with safety switch.
4. Travel Speed: 10 fpm (3.0 m/minute).
5. Motor: 2.0 hp (560 W).
6. Power Supply:
 - a. 120 VAC single phase; 60 Hz on a dedicated 20 amp circuit.

J. Platform Controls: 24 VDC control circuit with the following features.

1. Direction Control: Illuminated tactile and constant pressure elevator-style buttons with dual platform courtesy lights and safety light.
2. Illuminated and audible emergency stop switch shuts off power to lift and activates audio alarm with battery backup.
3. Keyed operation.

K. Call Station Controls: 24 VDC control circuit with the following features.

1. Direction Control:
 - a. Illuminated tactile and constant pressure elevator-style buttons with dual platform courtesy lights and safety light.
2. Keyed operation.
3. Call Station Mounting:
 - a. Lower:

- 1) Wall mounted surface.
- b. Upper:
 - 1) Wall mounted surface.

L. Safety Devices and Features:

1. Grounded electrical system with upper, lower, and final limit switches.
2. Tamper resistant interlock to electrically monitor that the gate is in the closed position and the lock is engaged before lift can move from landing.
3. Pit stop switch mounted on mast wall.
4. Electrical disconnect shall shut off power to the lift.
5. Under platform safety pan with five waterproof safety switches to detect obstruction under platform.

M. Finishes

1. Aluminum Extrusions: Champagne anodized finish.
2. Ferrous Components: Electrostatically applied baked powder finish, fine textured.
 - a. Color: Satin Grey, RAL 7030.
3. Lift Finish: Baked powder coat finish as selected by the Architect from manufacturer's optional RAL color chart.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify shaft and machine space are of correct size and within tolerances.
- C. Verify required landings and openings are of correct size and within tolerances.
- D. Verify electrical rough-in is at correct location.
- E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install platform lifts in accordance with applicable regulatory requirements including ASME A 17.1, ASME A 18.1 and the manufacturer's instructions.
- B. Install platform lifts in accordance with applicable regulatory requirements including CSA B355, and manufacturer's instructions.

- C. Install system components and connect to building utilities.
- D. Accommodate equipment in space indicated.
- E. Startup equipment in accordance with manufacturer's instructions.
- F. Adjust for smooth operation.

3.4 FIELD QUALITY CONTROL

- A. Perform tests in compliance with ASME A 17.1 or A18.1 and as required by authorities having jurisdiction.
- B. Perform tests in compliance with CSA B355 and required by authorities having jurisdiction.
- C. Schedule tests with agencies and Architect, Owner, and Contractor present.

3.5 PROTECTION

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

END OF SECTION



**CONTRACT DOCUMENTS
AND
SPECIFICATIONS**

DEPARTMENT OF GENERAL SERVICES

FOR

**Construction Services for Replacement
Senior Citizen Center**

Bid No. 99 – 2014

PREPARED BY:

**EOP Architects
201 West Short Street, Suite 700
Lexington, KY 40507**

July 29, 2014

Book 2 of 2

Set # _____

**PROJECT MANUAL BOOK 2 OF 2
TECHNICAL SPECIFICATIONS**

July 29, 2014

REFER TO BOOK 1 FOR DIVISIONS 1 - 14**DIVISION 20 – MECHANICAL SYSTEMS**

200100	GENERAL PROVISIONS
200300	REQUIRED SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS AND TOOLS
200500	COORDINATION AMONG TRADES, CONNECTION OF EQUIPMENT
200800	COMMISSIONING OF MECHANICAL & PLUMBING SYSTEMS
201100	SLEEVING, CUTTING, PATCHING AND REPAIRING
201200	EXCAVATION, TRENCHING, BACKFILLING AND GRADING
201300	PIPE, FITTINGS, AND SUPPORTS
201320	GEOHERMAL (EARTH-COUPLED) LOOP PIPING SYSTEM
201330	HEAT TRANSFER FLUID
202100	VALVES AND COCKS
202110	ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.
202200	INSULATION
202300	THERMOMETERS AND OTHERS, MONITORING INSTRUMENTS
202400	IDENTIFICATION, TAGS, CHARTS, ETC.
202500	HANGERS, CLAMPS, ATTACHMENTS, ETC.

DIVISION 21–FIRE PROTECTION

210100	FIRE PROTECTION
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DIVISION 22–PLUMBING SYSTEMS

220100	PLUMBING SPECIALTIES
220200	PLUMBING FIXTURES, FITTINGS, AND TRIM
220300	PLUMBING EQUIPMENT
221113	FACILITY WATER DISTRIBUTION PIPING
221313	FACILITY SANITARY SEWERS

DIVISION 23–HVAC SYSTEMS

230100	PUMPS
230200	HVAC EQUIPMENT
230300	CONDENSATE DRAINAGE
231100	REGISTERS, GRILLED, DIFFUSER, AND LOUVERS
231200	SHEET METAL AND FLEXIBLE DUCT

DIVISION 25–BUILDING AUTOMATION SYSTEMS

250200	CONTROLS – DIRECT DIGITAL
250300	AIR QUALITY MONITORING SYSTEM

DIVISION 26 – ELECTRICAL SYSTEMS

260501	GENERAL PROVISIONS
260502	SCOPE OF THE ELECTRICAL WORK
260503	SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, & SPECIAL TOOLS
260504	SLEEVEING, CUTTING, PATCHING, AND REPAIRING
260508	COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS
260519	CONDUCTORS, IDENTIFICATIONS, SPLICING DEVICES AND CONNECTORS
260526	GROUNDING AND BONDING
260531	CABINETS, OUTLET BOXES AND PULL BOXES
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260544	EXCAVATION, TRENCHING, BACKFILLING AND GRADING
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
260800	COMMISSIONING OF ELECTRICAL SYSTEMS
262400	ELECTRICAL DISTRIBUTION EQUIPMENT
262726	WIRING DEVICES AND PLATES
263213	EMERGENCY GENERATOR
264313	SURGE SUPPRESSION SYSTEM
265113	LIGHTING FIXTURES AND LAMPS

DIVISION 27 – COMMUNICATIONS SYSTEMS

270610	VOICE / DATA / VIDEO COMMUNICATIONS SYSTEM
270640	CATV DISTRIBUTION SYSTEM
275223	NURSE CALL

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY SYSTEMS

281600	SECURITY INTRUSION DETECTION SYSTEM
282300	DIGITAL VIDEO SURVEILLANCE SYSTEM
283100	FIRE ALARM SYSTEM

DIVISION 31 – EARTHWORK

311000	SITE CLEARING
312000	EARTH MOVING

DIVISION 32 – EXTERIOR IMPROVEMENTS

321216	ASPHALT PAVING
321313	CONCRETE PAVING
321373	CONCRETE PAVING JOINT SEALANTS
321400	UNIT PAVERS
321443	POROUS UNIT PAVING
323119	ORNAMENTAL METAL FENCE PANELS
329200	TURF AND GRASSES
329300	PLANTS

DIVISION 33 – UTILITIES

334100	STORM UTILITY DRAINAGE PIPING
334600	SUBDRAINAGE

END OF SPECIFICATION INDEX

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.
- E. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor, 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, 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) KBC - Kentucky 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 insure no conflict with other work.

- H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to insure 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 insure 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 insure 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 insure 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 insure 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 Kentucky Building Code (KBC) 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. Work in elevators, elevator shafts and elevator equipment rooms shall comply with the Elevator Code enforced by the Commonwealth of Kentucky.
 - K. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings and Construction, Commonwealth of Kentucky and the American Disabilities Act.
 - L. 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.
 - M. 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.
 - N. 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.
 - O. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings, and Construction, Commonwealth of Kentucky 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 warranties, 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 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) Heat Pump 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.

(2) Outside Air Units:

- a. These units shall not be used for temporary heating and cooling by the Contractor. They shall, however, be made operational, tested, etc. as specified during construction by the Contractor. Three complete sets of filters are required for each unit. In each unit, install one set of filters during construction. In each unit, install one set of filters at substantial completion. For each unit, leave third set of filters in boxes in appropriate mechanical room as a spare set for the Owner. Dispose of all construction filters.
- b. 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 insure 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 insure 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 2000 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). Insure, 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 insure 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.
- F. All filters shall be standard sizes and in frames.

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 as defined and clarified under Kentucky State Plumbing Law Regulations and Code. 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 insure 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.
- 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 KBC. 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. 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 "galvinox" 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, insure 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.

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 \$125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

END OF SECTION 200100

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 (External)
- Pipe Insulation
- Hydronic Specialties
- (2) Chemical Treatment System
- (1) Pumps and Circulators (HVAC)
- Geothermal Heat Pumps
- Outside Air Units
- CO₂ Monitoring System
- HVAC Controls
- Registers, Grilles, and Diffusers

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 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 insure 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 a combined symmetrical arrangements.

2. INTERFACING

The Contractor shall insure 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 Fire Protection System to domestic water service.
- C. Connection of Sanitary sewer house line to municipal service.
- D. Connection of Storm Drainage System to municipal system.
- E. Connection of Domestic Water System to Hydronic System.
- F. Connection of all controls to equipment.
- G. Electrical power connections to electrically operated (or controlled) equipment.
- H. 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.

END OF SECTION 200500

SECTION 200800 - COMMISSIONING OF PLUMBING AND MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.
- C. Commissioning Plan and Appendices.

1.02 SUMMARY

- A. Section includes commissioning process requirements for Conveying Systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 010800 - General Commissioning Requirements
 - 2. Section 010801 - Functional Testing
 - 3. Section 017900 - Demonstration and Training

1.03 SYSTEMS COMMISSIONED

- A. Domestic Hot Water System
- B. Geothermal Vault Sump Pump
- C. Elevator Sump Pump
- D. Geothermal Heat Pumps
- E. Geothermal Pumping
- F. Energy Recovery Ventilating Units
- G. Variable Frequency Drives
- H. Aircurity System
- I. Building Automation System

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Attend Construction Phase Commissioning Conference as part of Commissioning Team.
- B. Attend commissioning progress meetings as scheduled by Commissioning Authority.
- C. Respond to all Issues Tracking Log items identified by Commissioning Team within one (1) week of notification.
- D. Review and accept Functional Testing Procedures as prepared by Commissioning Authority.
- E. Perform functional testing as directed by the Commissioning Authority.
- F. Support Owner contracted functional testing as directed by Commissioning Authority.
- G. Perform seasonal functional testing as required by test procedures.
- H. Provide Plumbing and Mechanical systems, assemblies, equipment, and component maintenance orientation and training as described in specifications.
- I. Provide information requested by the Commissioning Authority for final commissioning documentation.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Provide project-specific Construction Checklists and Functional Tests for actual Plumbing and Mechanical Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Verify a sample of systems, assemblies, equipment, and component Construction Checklists.
- C. Observe equipment start-ups for the Geothermal Purge, Heat Pumps (qty 1), and Outside Air units.
- D. Witness a sample of systems, assemblies, equipment, and component functional testing executed by Contractor
- E. Compile test data, inspection reports, and certificates in Commissioning Report.
- F. Compile information into a project Systems Manual.
- G. Coordinate Owner Training
- H. Complete an 11 and 18 Month recommissioning review of system operations.

1.06 CONTROL CONTRACTOR'S RESPONSIBILITIES

- A. Due to the impact the Building Automation System has on the success of functional testing, the following supplemental requirements shall apply.
- B. Project specific responsibilities of Controls Contractor:
 - 1. Provide a written plan to the Commissioning Authority and Architect / Engineer describing process for completing checkout and start-up of Controls System.
 - 2. Refer to the specifications for controls for the scope of controls function verification the Commissioning Authority will complete after controls checkout.
 - 3. Provide resources to facilitate Functional Testing of Plumbing and Mechanical Systems, assemblies, equipment, and components including but not limited to technicians, any necessary unique instruments for setting terminal units or controllers, and passwords for control system interfaces.
 - 4. Provide resources to facilitate testing, adjusting, and balancing of Work. Refer to Section 1.08 "TAB Commissioning Specialties" and Specification Section 010801 – Functional Testing.
 - 5. Functional testing of controls shall be completed and approved prior to start of TAB work. Refer to Section 1.08 "TAB Commissioning Specialties" and Specification Section 010801 – Functional Testing.

1.07 TAB COMMISSIONING SPECIALTIES

- A. To facilitate the commissioning process the following requirements shall apply:
 - 1. Prior to TAB work, the Controls Contractor shall meet with TAB Contractor to coordinate capabilities and requirements of control system for use in TAB work. Verify with Commissioning Authority that controls Functional Testing has been completed and approved.
 - 2. Controls Contractor shall provide access to the TAB Contractor any unique instruments for setting terminal units, controllers, or other devices and instruct in their use.
 - 3. Controls Contractor shall provide a technician qualified to operate building controls to assist in TAB; coordinate scheduling with TAB Contractor.

1.08 COMMISSIONING SUBMITTALS

- A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.
- B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.

1. Duct Pressure Testing
2. System Flush-out Reports
3. Equipment and System Start-up Reports
4. Testing, Adjusting, and Balancing
5. Building Automation System Graphical Interface
6. Building Automation System Point-to-point Check

1.09 COMMISSIONING DOCUMENTATION

- A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:
1. Process and schedule for completing Construction Checklists for Plumbing and Mechanical Systems, assemblies, equipment, and components to be verified and tested.
 2. Construction Checklists for review and approval by Commissioning Authority and Architect / Engineer.
- B. In addition to the requirements detailed in applicable Division 20, 22, and 23 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report and Systems Manual:
1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 2. Test and inspection reports and certificates.
 3. Construction Checklists results.
 4. Completed Functional Test procedures.
 5. Responses to corrective action documents.
 6. Final version of the Basis of Design
 7. System single-line diagrams
 8. As-built sequences of operations, control drawings, and original setpoints
 9. Operations and Maintenance manuals for commissioned equipment
 10. A record of Owner training sessions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS PREPARATION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.02 CONSTRUCTION CHECKLISTS EXECUTION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

- A. Refer to Section 010801 – Functional Testing for complete procedures and requirements.

3.04 FUNCTIONAL TEST EXECUTION

- A. Refer to Section 010801 – Functional Testing for description of tasks to complete for this project.

3.05 GENERAL FUNCTIONAL TESTING REQUIREMENTS

- A. Refer to Section 010801 – Functional Testing for complete procedures and requirements.

3.06 POST ACCEPTANCE PERIOD

- A. Refer to Section 010801 – Functional Testing for complete seasonal or deferred testing procedures and requirements.

3.07 OWNER TRAINING

- A. Refer to Section 017900 – Demonstration and Training for Owner Training requirements for this project.

END OF SECTION 200800

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 is 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 insure 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 insure 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 insure 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 running any type of pipe below a footer, parallel or perpendicular to the footer, the area underneath the footer 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 footer. Where PVC piping is used within flowable fill, the pipe shall be isolated from the fill by a layer of heavy duty felt paper or cast iron piping may be used without a barrier. 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.
- E. Backfill for underground tanks shall be in accord with the tank manufacturer's recommendations. If in doubt, contact the Engineers.
- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.

- L. 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 Lines36 inches.
- B. Fire Protection Lines42 inches.
- C. Geothermal Lines42 inches.
- D. Storm Lines20 inches.
- E. Sanitary Lines (Exterior).....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).
- 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. 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.
- W. 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.
- X. 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.
- Y. 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. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.
- I. CPVC Plastic pipe; ASTM D2846.
- J. PVC plastic pipe; ASTM D1785.

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. Where not possible, run dead level.

D. Condensate Drain Lines From Cooling Equipment:

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

E. 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. Fire Protection - Exterior and Interior

Refer to the Fire Protection System section of these specifications.

C. 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.

D. 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.

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

(1) Service weight hubless cast iron pipe with manufacturer's approved bands.

F. Roof Leaders/Interior Storm Sewer Piping

(1) Service weight hubless cast iron pipe with manufacturers approved bands.

(2) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints.

G. Sump Pump Discharge

(1) Type "M" copper with solder joints.

H. 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%).

I. 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.

J. Hydronic Piping (Heat Pump Systems)

(1) Refer to Specification Section 201320.

K. Air Vent Discharge Lines

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

L. Condensate Drain Lines

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

(2) Schedule 40 PVC with solvent welded fittings.

M. Water Heater Relief Line

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

END OF SECTION 201300

SECTION 201320 - GEOTHERMAL (EARTH COUPLED) LOOP PIPING SYSTEM

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. INSTALLATION PERSONNEL AND TRAINING REQUIRED

- A. The loop installer, must have a current International Ground Source Heat Pump Association (IGSHPA) certification, having completed an IGSHPA training course in the fundamentals of design, installation, and operation of ground source systems, and having passed the IGSHPA certification examination.
- B. Ground heat exchanger fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician must be thoroughly familiar with heat fusion procedures, and have had formal training at a heat fusion school under direct supervision of an IGSHPA certified instructor.
- C. Local and state laws, ordinances, and regulations as they pertain to buried pipe systems shall be strictly followed.

3. GROUND HEAT EXCHANGER MATERIALS

- A. Piping shall be virgin polyethylene with a PE 4710 piping formulation and cell classification of 445576C or E per ASTM D 3350. Pressure ratings are at 73.4° F.
- B. 2" and smaller shall be SDR 9. Pressure rating of 255 PSI
- C. 3" and larger shall be SDR 15.5 or Schedule 40. Pressure rating of 135 PSI.
- D. Markings
 - (1) Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard.
 - (2) Piping shall also have permanent factory length markings.
- E. Certification
 - (1) Manufacturer shall supply a notarized document confirming compliance with the above standards.
- F. Manufacturers
 - (1) Centennial Plastics, Charter Plastics, Flying W Plastics, Lamson Vylon Plastics, Chevron Phillips, or Polypipe
- G. Warranty
 - (1) Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance. This applies to all pipe, fittings, transitions, valves, etc.

4. PIPE JOINING METHODS

- A. The only acceptable method for joining buried pipe systems is by a heat fusion process.
- B. Polyethylene pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures.
- C. Factory installed "U" bends shall be used at the bottom well bend.

5. CASING

- A. Casing shall be steel. PVC casing is not acceptable.
- B. The Contractor shall include in the bid an allowance for 20 feet of permanent left-in-place steel casing per each new geothermal well indicated on the drawings (excluding the previously installed test wells). The actual amount of casing used per hole shall be tracked with a casing log and wellfield schematic. Schematic shall depict geothermal wells and provide labels for each. Log shall state the bore hole number (as depicted on the schematic), date and time casing was installed, and linear feet of casing left in place for **each** bore hole. For example:

Bore hole # 1	8/1/09	2 P.M.	30 feet of casing installed
Bore hole # 2	8/2/09	9 A.M.	10 feet of casing installed

This log shall be kept current at all times and be **signed daily during drilling** by the well field installer, mechanical contractor, General Contractor and Owner's representative.

- C. Contractor shall submit a unit price for steel casing left in place on the Bid Form. In no case will a unit price greater than \$19 / linear foot be accepted. Bids not complying with this requirement may be rejected.
- D. The casing log and the submitted casing unit price will be used to reconcile the Contract Amount with the actual amount of casing installed. The Contractor will only be paid the full unit price for casing left in place. Push and pull casing (temporary casing) will be paid at half the rate for casing left in place.

6. GEOTHERMAL VAULT

A. General

This specification designates the requirements for the geothermal vault including internal pipe, fittings, and valves.

B. Internal Piping

Shall be constructed of Drisoplex 5300 Climate Guard High Density Polyethylene SDR 15.5 pipe having a cell classification of 345444 with a UV stabilizer of C. This internal pipe is constructed in an offset, over and under, model for supply and return lines. All joints to be heat fused. The entire piping system to be tested using 150 psi nitrogen. The main supply and return pipe to be shipped with cap butt welded to pipe. All pipe penetrating the vault walls shall be SDR9 and heat welded to external shell.

C. Fittings

P/T Plugs: Shall be constructed of solid brass and have a dual seal core of Nordel, good up to 350°F for water. Plugs shall be rated zero leakage from vacuum to 1000 psig and are capable of receiving a pressure or temperature probe. Each HPS & R pipe to the well field shall have a P & T port.

Butterfly Valve: Shall be constructed of a cast iron body, 416 stainless steel stem with a lever shut off system.

90° Elbows: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

Branch and Service Saddles: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

Valving: Each row of 10 wells shall have HPS & R shut off butterfly valve and each return line shall have a bell & gossett circuit setter for balancing.

Drain: Provide a 4" floor drain in each vault.

D. Installation

The vault shall be lowered into a pit with a 6" bed of #57 gravel. Once the vault is in its place, concrete is poured as recommended by the manufacturer in and around the vault to balance buoyancy pressure and allow for anchoring. The manhole shall be flush with finished grade.

7. FLUSHING, PURGING, PRESSURE AND FLOW TESTING

A. General

- (1) Coordinate this section with the cleaning and flushing listed in Section 230200 - HVAC Equipment.
- (2) All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage.

B. Pressure Testing

- (1) Vertical loops shall be pressure tested before installation. All horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling. Pipes must contain fluid under pressure during backfilling.
- (2) Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure if this value is the smaller of the two. No leaks shall occur within a 48 hour period. Engineer shall be notified when system is to be placed under pressure test.

C. Flushing and Purging

- (1) Notify the Engineer a minimum of 2 weeks in advance of system flushing. The Engineer, Mechanical Contractor, Heat Pump Supplier, Test and Balance Contractor, and Well Field Installer shall all be present to observe system flushing and purging. Schedule the system flushing to occur the same day as a regularly scheduled progress meeting. The Engineer **MUST BE PRESENT**. Failure to notify the Engineer in advance will result in the Contractor having to flush the system a second time.
- (2) Flow rates shall be compared to calculated values to assure that there is no blockage or kinking of any pipe. Submit this in writing to the Engineer. Balance Contractor to verify.
- (3) A minimum velocity of 3 ft/sec in each piping section must be maintained until all air is removed. The system shall also be forward and reverse flushed to remove all debris. The building shall be flushed in sections as required to maintain high velocities. Building mains shall be flushed separate from branches to maintain high velocity when flushing the mains.

- (4) Final purging of air from the entire building and loop field shall be performed by the Well Field Installer so that air in building piping will not be transferred to the well field.
- (5) The Balance Contractor must witness and confirm all pressure tests and flushing velocities along with confirm pressure drop for each geothermal well zone.
- (6) Contractor shall provide full size connection ports and valves as required to purge wellfield and building separately.
- (7) After the heat pump bypasses are flushed and the piping network is determined to be clean and free of air, the heat pumps themselves shall be flushed.
- (8) The system flushing device shall be equal to a Purge Pro Max distributed by Geothermal Supply Company. The flushing pump shall provide performance equal to or exceeding the following values: 550 GPM at 117 PSI, 500 GPM at 115 PSI, 300 GPM at 125 PSI, dead head pressure of 128 PSI. SUBMIT PUMP CURVE to Engineer for review and approval prior to system flush. The flushing device shall provide means to release entrained air to the atmosphere and shall filter the water. Filter shall be 50 micron. Water shall be circulated and filters shall be changed until debris is no longer visible on filter. Contractor shall provide filter media as required.

8. HORIZONTAL PIPING SYSTEMS

- A. Sharp bending of pipe around trench and bore hole corners must be prevented by using a shovel to round corners. Manufacturer's procedures must be followed.
- B. Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling, backfilling through a coarse screen for a 6 inch cover, or use of a 6 inch cover of rock-free soil. Clods resulting from use of a backhoe must be broken up so as not to form air pockets around the pipe which will reduce heat conduction between the earth and the pipe. The flow of backfill soil must be controlled to prevent bridging and the formation of air pockets. Several slow passes with an angled backfill blade are required. Flooding is required to assure removal of air pockets. Since most of the horizontal piping is below the parking lot, the backfill shall support the expected bus traffic. Backfill load bearing capacity shall meet the Architect's specification.
- C. Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.
- D. All horizontal piping shall be a minimum of 42 inches below finished grade.

9. BORE HOLE

- A. The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend, but shall be no less than 4-1/2".
- B. The entire bore shall be grouted as recommended by IGSHPA with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-°F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer's recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube. Through the course of the project, three sample grout specimens shall be taken of the mixed grouting material by this contractor. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This contractor shall submit these reports to the Owner, Architect and Engineer to verify compliance with the installation specifications.
- C. If large water seams are encountered, bridging across water seams with #7 or #9 rock, or GeoPro Black Hills 3/8 inch Bentonite Plug, is acceptable. The maximum height of the rock or bentonite

bridge shall not exceed 8 feet. The remainder of the vertical bore hole shall be grouted per the above specification. Bore holes with water seams shall be monitored for settling of grout. After a period of one week, all holes shall be topped off with grout as needed. The Contractor shall continue to monitor holes that experience grout settling and continue to top off with grout throughout the warranty period. Bore holes that are unable to hold grout shall be replaced with new bore holes at no cost.

- D. The Contractor shall accept the site as-is and is responsible for any and all required casings. If an area of voids is encountered, the Contractor shall either fill or re-drill wells in an approved area and extend piping to them.
- E. No night drilling will be allowed.

10. DUST CONTROL

- A. The Contractor is responsible for and shall provide dust control. Dust shall not be allowed to leave the construction site boundaries, and furthermore, shall not be allowed to enter the building or accumulate on the building exterior. When needed to meet these requirements, the Contractor shall provide and operate a mechanical dust collection system to control dust at the source. Mechanical dust collection system shall consist of collection hood at the source ducted to a dust collector which separates dust from the airstream. Dust shall be collected into sealed containers for disposal by the Contractor.
- B. Water spraying may be used but shall not be considered a substitute for mechanical dust collection at the source when required.

11. SURFACE WATER / MUD / SLURRY CONTROL

- A. The Contractor is responsible for and shall provide control of all ground flowing fluids resulting from drilling operations. The Contractor shall erect silt fences or other structures as required to contain drill cuttings, mud, slurry, etc. within the construction site boundaries. In the event this requirement is not met, the Contractor shall provide all remediation measures as required by all authorities having jurisdiction over such events.

12. WARRANTY

- A. The entire ground loop system and backfill from a point 5 feet inside the building shall be warranted for **five (5) years** from date of substantial completion against any leakage or failure. Warranty service for a pipe leak shall include recharging system with heat transfer fluid as originally specified, including glycol or ethyl alcohol if originally specified, as well as corrosion inhibitors.

13. BALANCE

The Contractor shall assist the Balance Contractor in balancing the geothermal well zones to obtain the specified flows.

14. SUBMITTALS

- A. Submit manufacturer's specification sheets and installation instruction for each component of the system, showing manufacturer, pipe or tube weight, pressure rating, fitting type and joint type for each piping system.
- B. Submit manufacturer's mechanical data for valves.
- C. Submit a drawing indicating the system layout and pipe sizes.

- D. Provide a copy of the technician's certification, and International Ground Source Heat Pump Association Certification.

15. TEST BORES

1. Two 300 ft. test bore with associated report delineating geological materials and conditions encountered, i.e., voids, water, limestone, etc.
2. 1" polyethylene piping shall be installed in the test bore. This shall be installed by a certified water well driller to ensure no encountered aquifers are compromised. Bore holes shall be grouted as recommended by IGSHPA to ensure good heat transfer. Local and state laws and regulations for backfilling requirements shall be followed. See IGSHPA Grouting Procedures Manual for detailed grouting procedures. The bore hole annulus shall be completely grouted to ensure there are no air voids and to ensure there is consistent contact between the vertical piping and the bore hole formation. This will required the bore annulus to be filled with grout from the bottom to the top with a "tremie" tube. The entire bore shall be grouted with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-°F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer's recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube. One grout specimen sample shall be taken of the mixed grouting material by the contractor. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This contractor shall submit these reports to the Engineer to verify compliance with the installation specifications.
3. A 48 hour thermal conductivity test shall be performed on the installed well in accordance with accepted industry practice.
4. A site layout showing the location of the bores is included in the contract documents.

END OF SECTION 201320

SECTION 201330 - HEAT TRANSFER FLUID

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. The work under this section shall be closely coordinated with work involved with cleaning and flushing the system.

2. HEAT TRANSFER FLUID

- A. The heat transfer fluid shall be Environol, DuPont, Dow, Union Carbide or approved equivalent non-toxic antifreeze (heat transfer fluid) formulated for use in ground source heat pump systems. The heated transfer fluid shall be equivalent to a 28% Environol 1000 solution to provide a 10NF freezing point. The heat transfer fluid shall be premixed and ready to use.
- B. The heat transfer fluid shall be a denatured alcohol based solution containing ethyl alcohol, DI water, sodium metal bisulfite, pine oil, denatonium benzoate, isoprophyl alcohol, methylene blue with the following characteristics before dilution:

Boil Point:	173°F
Freezing Point:	-150°F
Vapor Pressure:	44.6mm Hg at 68°F
Specific Gravity:	0.80 at 60°F
Vapor Density (AIR-1):	1.59
Solubility in Water:	Substantially

- C. The heat transfer fluid shall include corrosion inhibitors.
- D. The fluid shall not exceed the following National Fire Protection Association (NFPA) Hazardous Material Rating Codes:

Health:	0
Flammability:	3
Reactivity:	0
- E. The heat transfer fluid shall be handled in strict accordance with US Department of Transportation Regulations, NFPA Standards, and all local and state codes and regulations.
- F. All scale, rust, sediment, pipe dope, etc., must be removed from the system. The piping system must be thoroughly cleaned before introducing the heat transfer fluid into the system.

3. SYSTEMS

- A. The heat transfer fluid shall be used to charge the hydronic heat pump system.

4. SUBMITTALS

- A. Before introducing the heat transfer fluid into any system, submit manufacturer's data sheets to the Engineer for review.

END OF SECTION 201330

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.
- 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 insure 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. 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).

C. 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. NIBCO T5800-70. All ball valves to be full port.

D. 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 boxring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Appollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is 1/4" above the insulation. NIBCO S-585-66-LF. All ball valves to be full port.

E. 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.

F. 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.

G. AIR COCKS

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

H. GAUGE COCKS

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

I. 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.

J. 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 marked with colored tacks 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 (12) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to insure that it is air tight. Manually check the size and location of each of these openings to insure that the fire damper may be manually reset by use of hand only.

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 other 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 is 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 vaporseal, 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, storage areas, or unfinished rooms 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 insure 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) Geothermal piping systems, if required to be insulated, shall be insulated continuously like a chilled water system. This requirement extends to all components in the system (pump impeller housing, unions, flanges, valves, air separators, sidestream filters, hydronic specialties, etc.).
- (3) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to insure no condensation drip or collection.
- (4) 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.
- (5) 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.
- (6) 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
 - a. Piping 3" or less – use 1/2" thick insulation.
 - 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.
 - 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.
 - a. Piping 1 1/2" or less – use 1 1/2" thick insulation.
 - b. Piping 2" or greater – use 2" thick insulation.
- (5) Geothermal Heat Pump Piping
 - a. Piping 1 1/2" or less – use 1/2" thick insulation.
 - b. Piping 2" and greater – use 1" thick insulation.
- (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

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 insure 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.

B. EXTERNAL INSULATION

- (1) Supply Air
- (2) Outside Air

Owens/Corning "Faced Duct Wrap - Type 150", or approved equal, 1-1/2" thick fiberglass duct wrap, **1-1/2 lb.** 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 1 1/2" thick insulation shall be 5.7.

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. EXPOSED EXTERNALLY INSULATED DUCT

- (1) Round. 1 1/2" 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 5.5. 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.

D. EXTERNALLY INSULATED DUCT – OUTDOORS

- (1) 2" semi-rigid fiberglass industrial board with foil scrim kraft vapor barrier facing or PSK Facing, 3.0 PCF density, K=.23 @ 75°F. Minimum R-value of 8.7. Owens/Corning, or approved equivalent industrial installation type 703. Weather proofing shall be ductmastic adhesive and sealer rated for outdoor use, Hardcast Flex-Grip 550, or approved equivalent.

- (2) As an alternative to duct mastic adhesive and sealer, Contractor may provide a field applied aluminum jacket meeting the following specification:

Aluminum Jacket Material: Smooth finished sheets manufactured from 0.024 inch thick aluminum alloy complying with ASTM B209 and having an integrally bonded 10mil thick, heat-bonded polyethylene and kraft paper moisture barrier over entire surface in contact with insulation.

Aluminum Jacket Applications: Apply aluminum jacketing to all external ductwork that is externally insulated. Cover all fittings and specialties with aluminum jacketing. Provide a 2-inch overlap at longitudinal seams and end joints. Secure jacket with stainless-steel sheet metal screws 6 inches o.c. and at end joints. Overlap longitudinal seams arranged to shed water and seal end joints with weatherproof mastic.

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.

C. EXPANSION TANK, COMPRESSION TANK, AIR SEPARATOR, HEAT EXCHANGER, SIDESTREAM/LOOP FILTERS, AND HOT WATER STORAGE TANKS

- (1) Owens-Corning "Tank Wrap I" or approved equivalent. Insulation shall be constructed of non-combustible, flexible wool. Insulation shall be 2" thick. K factor shall be .29 at 100°F. mean temperature. Insulation shall be attached in strict accordance with the manufacturer's recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging. Coordinate with mechanical contractor to extend all piping connections, blowdown ports, etc. outside of the insulation. Additionally for loop filters and other equipment requiring periodic service, provide removable insulated covers.

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:

G	Geothermal Heat Pump
DCW	Domestic Cold Water
DHW	Domestic Hot Water
RHW	Recirculating Hot Water
FP	Fire Protection

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.

3. PIPING IDENTIFICATION

A. GENERAL

- (1) All exposed piping installed shall be painted according to the color coding chart hereinafter specified. In addition, provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract after the piping has been painted. 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".

B. PAINTING (REFER ALSO TO ARCHITECTURAL SECTION ON PAINTING)

- (1) 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.
- (2) Paint exposed pipe (whether insulated or bare) and exposed surfaces (tanks, etc.).
- (3) All piping shall be painted in accordance with the following color coding chart.

PIPE+	PIPE COLOR CODE+	ABBREVIATION
Geothermal Supply*	Green with Black Letters	G.S.
Geothermal Return	Green with Black Letters	G. R.
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.
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.

- C. Water heaters, storage tanks, heat exchangers, etc., shall be painted light gray.
- D. 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.
- E. 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.
- F. In mechanical rooms, piping shall be labeled every 10 feet.

4. 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.

5. 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.

6. 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	Grinnel 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	Grinnel 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. Polyethylene piping – 4 foot intervals for piping 2" and smaller. 5 foot intervals for 3" pipe. 6 foot intervals for 4", 6", and 8" pipe. 7 foot intervals for 10" and larger pipe.
- c. 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.
- d. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

END OF SECTION 202500

SECTION 210100 - FIRE PROTECTION SYSTEM

1. GENERAL

- A. The General Conditions, Instructions to Bidders, Section 200100, 1. A, and other Contract Documents are a part of this specification and shall be binding on the Contractor. It shall be the 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. No Contractor, other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems, will be considered or approved for the work under this section of the specifications. Bidders must have had not less than five (5) years experience in the fabrication and erection of such systems: wet, dry and rack storage types, and shall have completed installations similar and equivalent in scope to this system under approval by one or more of the recognized Underwriting Associations in the Insurance Field.
- C. Before submitting bid, examine all Mechanical, Architectural, and Structural Drawings, visit the site and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. Also, the Contractor shall coordinate with the rating bureau and insuring agency to verify adequacy of water supply for the proposed sprinkler system extension.
- D. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Where variations exist between described work and approved practice, the Engineer shall be consulted for directive.
- E. It is the intent of the Plans and Specifications to provide a general layout only and locate major equipment, piping, etc. Variations in head locations, pipe routing, etc., may be anticipated by the Contractor and shall be coordinated with all other trades and indicated on the drawings and descriptive literature called for hereinafter. It shall be the express responsibility of the Contractor to provide all required materials and equipment and perform all work required to install a complete and approved installation.
- F. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and the State Fire Marshal. Also, all work shall comply with the latest editions of the National Board of Fire Underwriters, National Fire Protection Association, OSHA Regulations, the National Building Code, the Life Safety Code, IMC Code and the Southern Building Code (Where applicable). The local insuring agency shall review plans prepared and submitted by the Contractor but shall have no authority to make changes once work has begun.
- G. All work performed under this section shall be accomplished in close harmony with all other trades. All work not so coordinated shall be removed and reinstalled at the expense of the Contractor.
- H. The Contractor shall submit a proposed layout to the Engineer prior to submittal to the Fire Marshal's Office.

2. SCOPE OF WORK

- A. Furnish all material, labor, tools, equipment and supervision required for installation of a complete fire protection and stand pipe system as indicated on the project drawings. Include all necessary piping, sprinkler heads, test connections, valves, drains, cabinets, siamese connections, fire hydrants, fire pump, etc.
 - B. The Contractor shall provide flushing and sterilization of all water lines in accordance with current Kentucky Plumbing Codes, Rules and Regulations and shall make connection to domestic water mains in accord with current rules and regulations of the State Department of Sanitary Engineering and Division of Water.
 - C. Provide stand pipes with fire hose cabinets or fire valves as indicated or as required to meet the requirements of NFPA and the local fire authority.
 - D. Provide sprinklers in attics, overhangs, awnings, cooler/freezers, in accessible spaces and all other areas required by NFPA and the local fire authority.
 - E. Provide dry pipe systems or freeze proof heads as required to provide continuous coverage without freezing.
3. WATER SUPPLIES AND SYSTEM LAYOUT CRITERIA
- A. Where flow and pressure data are available, they are indicated on the project drawings. The Contractor shall independently verify all such information and notify the engineer of any discrepancies discovered prior to beginning the work. Where no flow information is indicated on the project drawings, the Contractor shall obtain it and indicate it on the shop drawing submittal. Piping systems shall be hydraulically sized based on the most conservative flow information obtained. No adjustments in the contract amount will be allowed for failure of the Contractor to obtain adequate flow information.
4. DRAWINGS AND DESCRIPTIVE LITERATURE
- A. The Contractor shall prepare and submit to the Engineers, seven (7) copies of detailed drawings indicating his proposed Automatic Sprinkler System. These drawings shall indicate minimally the following components when they are used in the system.
 - (1) Name and address of Owner, Architect and Engineers.
 - (2) Make and type of sprinkler heads (Catalog cuts).
 - (3) Make and type of fire department connection (Catalog cuts).
 - (4) Make and type of post indicator valve (Catalog cuts).
 - (5) Make and type of detector check valve (Catalog cuts).
 - (6) Make and type of water motor gong (Catalog cuts).
 - (7) Make and type of retard chamber (Catalog cuts).
 - (8) Make and type of dry pipe alarm valve (Catalog cuts).
 - (9) Make and type of flanged check valve (Catalog cuts).
 - (10) Make and type of flanged gate valve (Catalog cuts).
 - (11) Make and type of automatic drains (Catalog cuts).
 - (12) Make and type of pipe hangers (1 catalog cut of each make and/or type).
 - (13) Make, type and electrical characteristics of:
 - a. The pressure sensing switch*.
 - b. The post indicator supervisory switch*.
 - c. The main gate valve supervisory switch*.
 - d. The flow switch*.

e. Air compressor.

- (14) Make and type of fire pump (Catalog cuts).
- (15) Make and type of jockey pump (Catalog cuts).
- (16) Make and type of supervised O.S & Y valve.
- (17) Make and type of indicating butterfly valve.
- (18) Make and type of fire hose cabinets.
- (19) Make and type of reduced pressure backflow preventer.

Note: All layouts and drawings are to be closely coordinated with the work of all other trades. The Engineers will, upon request, provide a complete set of Architectural, Structural, Mechanical and Electrical Plans and Specifications to aid the Contractor in this work.

*SPECIAL NOTE: 1) The items (indicated by asterisk) must be clearly coordinated with the Fire Alarm System supplier. 2) Supervisory switches located in wet locations (i.e., fire protection vault) shall be provided with NEMA 6 enclosures.

- (20) On a set of drawings to the same scale as the drawings accompanying these specifications, indicate:
 - a. Each head location coordinated with lights, diffusers and other ceiling mounted device.
 - b. Location of all risers, mains, runout lines, etc.
 - c. Size of all risers, mains, runout lines, etc.
 - d. Location and type of pipe hangers.
 - e. All other information required by the Kentucky Department of Housing, Buildings and Construction.

The Contractor shall submit these drawings to the Engineer through the General Contractor/Construction Manager and Architect where applicable. The Contractor shall submit reviewed drawings to the Kentucky Department of Housing, Buildings and Construction for their review and approval. No work shall be done until drawings are approved by the Kentucky Department of HBC.

5. SYSTEM DRAINAGE

- A. The entire Standpipe and Sprinkler System (except that part which is below grade and will not freeze) shall be installed so as to allow 100% drainage.
- B. All sprinkler branch piping shall be installed so as to drain back to the main riser.
- C. Approved 2" drawoff piping shall be provided on sprinkler risers with discharge piping running to nearest floor drain or open air.
- D. Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and neatly installed.
- E. All draw-offs shall have a metal tag labeled "Sprinkler Drain."

6. INSPECTIONS AND TESTS

- A. Furnish all labor, equipment and conduct all required tests in the presence of the Owner and Engineer or designated representative.

- B. All piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 PSI and maintained for not less than two (2) hours.
- C. Upon completion of his work, the Contractor shall submit a written and signed certificate to the Engineers indicating that he performed the above prescribed tests and rectified all malfunctions arising there from.

7. PERMITS

- A. The Contractor shall obtain and pay for all necessary state, municipal, county, city and other permits and fees and pay all State taxes which are applicable.

8. GUARANTEE

- A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, for a period of one year after date of final acceptance.

9. ACCEPTANCE CERTIFICATE

- A. Upon completion, the Contractor shall submit to the Engineers, a properly filled out "Sprinkler Contractor's Certificate Covering Materials and Tests." (4 copies).

10. CLEANING

- A. Upon completion of this work all debris, material, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for finish painting. Note: Do not remove rust inhibitive primer specified hereinafter.

11. PAINTING

- A. All fire protection piping, fittings, etc., shall have one factory or shop coat of rust inhibitive primer. The Contractor shall thoroughly clean all such items in areas where the piping will be exposed so as to readily receive the finish coat specified in the Architectural Division of Painting. Colors shall be as specified in Identification Section of these specifications.

12. PIPE LAYING

- A. Bell holes shall be excavated accurately to size and barrel of pipe shall bear firmly on bottom of trench throughout its length. All foreign matter and dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. At times when pipe laying is not in progress, the open ends of pipe shall be closed by approved means, and no trench water shall be permitted to enter the pipe. Cutting of pipe, where necessary, shall be done in a neat and workmanlike manner, without damage to pipe. Refer also to Excavation.

13. EQUIPMENT AND MATERIALS

- A. Signs

Appropriate code approved and required signs shall be installed on all control valves, drains, inspector's test, etc., indicating the function, installation, etc. Signs shall be neatly affixed with rust inhibitive screws, rivets or where hung from piping; with stainless steel No. 14 AWG wire.

B. Finish

All exposed materials such as valves, fire department connections, sprinkler heads, fire pump test headers, etc., shall be brass or chrome-plated brass.

C. Check Valves

- (1) 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; flanged; equivalent to Mueller, Scott or Lunkenheimer.
- (2) 2" and under; 150# working pressure; bronze; screwed; equivalent to Jenkins, Scott or Lunkenheimer.

D. Pipe & Fittings

- (1) Nipples and fittings shall be of same material, composition, and weight classification as pipe in which installed.
- (2) Up to 2" (Interior) Schedule 40 ASTM A-53 black steel; 125# cast iron screwed fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.
- (3) 2-1/2" and larger (Interior) Schedule 40 black steel with flanged, welded or victaulic (or similar) type approved fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.
- (4) Blazemaster or approved equivalent CPVC SDR 13.5 pipe UL listed for fire protection use. CPVC is not allowed for dry pipe systems and is only allowed in light hazard occupancies. Piping must be installed in accordance with the manufacturer's recommendation and all governing bodies having jurisdiction.
- (5) Exterior: Class 200 PVC piping for exterior fire protection piping. Piping shall meet AWWA C900 requirements, be UL listed, Factory Mutual approved and NSF approved. Joints shall have spigot pipe ends with a flexible elastomeric ring seated in a groove to provide water tight seal. Minimum burst pressure to be 900 psi when tested in accordance with ASTM D1599. No. 8 copper wire (tracer wire) shall parallel all exterior PVC pipe.
- (6) Dry Pipe System Piping: Same as standard system except Schedule 10 piping is not acceptable.

E. Clamps and Anchors

- (1) Furnish and install approved clamps, as required, at all (45 degree) 1/8 bends, (90 degree) 1/4 bends and flange and spigot pieces to the straight pipe to insure permanent anchorage of all fire lines. Clamps, clamp rods, nuts, washers, and glands shall be coated with a quick drying coal tar bituminous paint after installation.

F. Hangers

- (1) All piping shall be adequately and permanently supported in an approved manner on approved hangers (Submit with drawings).

G. Sleeves and Escutcheon Plates

- (1) Furnish and install sleeves for pipes where piping penetrates masonry walls; exterior wall sleeves to be watertight. Fire and smoke stop all penetrations through fire and smoke walls and coordinate with General Contractor for locations.
- (2) Furnish and install cast brass chrome plated split ring type escutcheons where piping penetrates walls, ceilings and floors, whether in finished areas or not.

H. Electric Wiring

- (1) All electric wiring for the system which may be required shall be installed in accordance with the National Board of Fire Underwriters, and National Electric Code. The cost of this electric wiring shall be included under this Contract. All electrical wiring and conduit installed in fire protection pits shall be sealed watertight.

I. Inspection Test Connections & Pressure Gauges

- (1) A 1" inspection test connection as required by the Kentucky Building Code. Discharge shall run to open air.
- (2) Control valve for test connection shall be installed not over 7' above the floor.
- (3) A pressure gauge at the inspection. Test connection at each location indicated on the Plans. Pressure gauges shall be 2-1/2" diameter and readable from the floor.

J. Gate Valves

- (1) 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; OS&Y; flanged; cast iron discs; bronze seat rings; four point wedging mechanism; equivalent to Mueller, Scott or Lunkenheimer.
- (2) 2" and under; 150# working pressure; bronze; rising stem; screwed; bronze discs; bronze seat rings; two point wedging mechanism; equivalent to Jenkins, Scott or Lunkenheimer.

K. Sprinkler Head Cabinet

- (1) Furnish and install a cabinet, clearly labeled, with four (4) sprinklers of each type complete with required wrenches. Locate as directed by Engineer. Label "Sprinkler Heads."

L. Fire Department Connection

- (1) Furnish and install a fire department connection with threads as approved by the local fire department; cast brass polished and chromium plated; with connection sizes and lettering as directed by the local authority having jurisdiction.

M. Fire Department Connection

- (1) Furnish and install a fire department connection with threads as approved by the local fire department; cast brass polished and chromium plated; with connection sizes and lettering as directed by the local authority having jurisdiction; Units shall be Acron Brass or equal single 4" nozzle, clapper, etc.

N. Fire Valve Cabinets

- (1) Manufacturer. The products specified hereunder shall be Crocker or equivalent by Larsen's Mfg. Co., J.L. Industries, Kidde, or other nationally recognized manufacturer of cabinets conforming closely to specification requirements.
- (2) Valve cabinets for recessed installation at all locations where shown shall be similar to Crocker Model No. 2700 with flat trim and clear glazed full glass door. Provide 18 gauge steel tub, 20 gauge steel door, 16 gauge steel frame, and white enamel finish interior with all exposed exterior portions painted with color selected by Architect.
- (3) Each cabinet shall be equipped with one 2-1/2" (or as required by the local authority) Fire Department valve with cap and chain. All connections and threads shall be as required by the local authority.

O. Fire Hose Valve

- (1) Manufacturer. The products specified hereunder shall be Crocker or equivalent by Elkhart, Central Sprinkler, Kidde, or other nationally recognized manufacturer of hose valves conforming closely to specification requirements. Valve shall be with cap and chain. All connections shall be 2½" or as required by the local authority.

P. Siamese Hose Connection

- (1) Furnish and install on the fire protection pit where required by the local authority a siamese hose connections with threads as approved by the local Fire Department. Unit shall be similar to Larsen's No. 15 sidewalk siamese, size: 2-1/2" x 2-1/2" x 6". Coordinate threads type with local Fire Department.

Q. Post Indicator Valve

- (1) Furnish and install a post indicator valve as required by the local authority. It shall be listed and approved by Underwriters Laboratories and Associated Factory Mutual Laboratories; Marked SV-FM; vertical; non-adjustable; with electric supervisory switch, handle, view window, brass padlock with (2) keys; gate valve to meet gate valve specifications, except to have non-rising stem and mechanical joint ends; equivalent to Mueller, Scott or Lunkenheimer.

R. Detector Check Valve

- (1) Furnish and install detector check valve as required by the local authority. It shall be listed and approved by Underwriter Laboratories and Associated Factory Mutual Laboratories; 175# working pressure; IBBM; flanged; with tapped bosses each side for by-pass meter trimming; equivalent to Viking, Badger or Grinnell.
- (2) The Contractor shall contact the servicing water company and ascertain their policy pertaining to the by-pass water meter; if not furnished by water company. The Contractor shall furnish and install the by-pass meter and trimming as detailed on the drawings.

S. Sprinkler Heads

Gem, Grinnell, Star, Viking, Reliable, Central or approved equivalent as follows:

- (1) Where piping is exposed: "Standard up right."
- (2) Where piping is concealed above finished ceilings, provide two pieces, semi recessed, white plated sprinkler heads with removable escutcheon.
- (3) Install sprinkler head guards where heads are subject to physical abuse. Heads located below seven (7) feet above floor, etc.
- (4) Sprinkler head degree ratings shall be determined by the area serviced in accord with current Codes and Standard Practices. Indicate degree ratings on submitted Shop Drawings.
- (5) The Contractor shall submit to the Engineer for inspection, one (1) sample of each type of sprinkler head, proposed to be used on the project.
- (6) Where heads are installed in a tile ceiling, they shall be installed in the middle of the tiles, at half or quarter points along the length of the tiles. Install sprinkler heads at quarter points of center scoured 2' X 4' ceiling tiles.
- (7) Provide high temperature heads around range hoods, kitchen equipment, kilns, boilers, water heaters and other heat producing equipment.

T. Water Motor Gong

- (1) Furnish and install a water motor gong.
Grinnell, Viking, Mueller or equivalent.

U. Retard Chamber

- (1) Same as water motor gong.

V. Flow Indicator Switches

- (1) Furnish and install flow indicator switches as required by NFPA 13. All flow indicator switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer. Provide a set of dry contacts on each flow switch for interface to the Control System if this control point is specified in the Controls Section.

W. Tamper Switches for Water Shut-Off Valves

- (1) Furnish and install tamper switches where required by NFPA 13. All tamper switches shall be UL approved. Coordinate with fire alarm system supplier/installer. All tamper switches located in fire protection pits shall be waterproof, capable of operating beneath water similar to Potter PTS Series and be NFPA approved.

X. Reduced Pressure Backflow Preventer

- (1) Refer to plumbing specialties section of these specifications.

14. GUARANTEE

- A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, or vandalism, for a period of one year after date of final acceptance.

END OF SECTION 210100

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 Kentucky Building 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 insure 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 KBC.
 - 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. Where they are not to receive paint, they shall be polished bronze unless otherwise indicated where they are to receive paint or other finishes. They may, at the Contractor's option, be Perma-Coated steel, prepared to receive finish.
- (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., insure 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 and/or as required by Kentucky Building Code. Install in a neat and workmanlike manner. Coordinate locations with appropriate persons or party to insure floor pitch to drain where required.
- (2) Install floor drains in strict accordance with manufacturer's recommendations and the KBC 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) Insure 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 - Zurn, Z-415 with 6" X 6" top, Type "S" strainer. Provide with trap primer connection.
 - b. FD-2 - Zurn, ZN-610 with 12" X 12" locking grate, secondary strainer, sediment bucket, and galvanized cast iron construction with trap primer connection.
 - c. FD-3 - Zurn, Z415 with Type "E" strainer with 4" diameter funnel. Provide with trap primer connection.

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)

Precision Plumbing Products Prime-Time or equal electronic trap priming manifold, with atmospheric vacuum breaker, pre-set 24 hour clock, manual override switch, 120 volt solenoid valve with 120v/3wire connection. Provide in 12" x 12" x 4" surface mounted metal cabinet. Provide with 10 opening manifold, un-used manifold opening shall be capped. Install united as required by manufacturer.

(2) Trap Primer Type-2 (TP-2)

Precision plumbing products Prime-Rite or equal trap primer shall be installed on a cold water line, with distribution unit(s) to serve 1 to 8 drains. Install per manufacturer's recommendations.

E. CLEANOUTS (EXTERIOR) (ECO)

Provide exterior cleanouts at each location indicated and in the manner indicated. Permanently set all exterior cleanouts centered in a 30" X 30" X 6" deep concrete pad. The top of the concrete pad shall be flush with finished grade. The top of the cleanout box shall be flush with the top of the pad and shall be stamped "CO."

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, Zurn, Z-100 15", or equivalent, diameter roof drain, dura-coated cast iron body with combination membrane flashing clamp/gravel guard and low silhouette cast iron dome. Provide with any accessories needed for installation in roof specified by Architect and as recommended by the roofing manufacturer.
- (3) RD-2 (Overflow Roof Drain with external water dam) Zurn, Z-100-89 , or equivalent, 15" diameter roof drain, dura-coated cast iron body with 2" high combination membrane flashing clamp/gravel guard and low silhouette cast iron dome. Provide with any accessories for installation in roof specified by the Architect and as recommended by the roofing manufacturer.

G. HEADWALLS (HW)

Provide at the locations indicated and/or as required by Federal, State and/or local codes, rules, regulations, standards and/or requirements, headwalls of the type required or indicated. Install as prescribed by local authority or as indicated, whichever is superior.

H. 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 KBC.
- (2) Where required by the KBC, 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 insure 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. Zurn 1300 or equivalent, 3/4", encased, flush, non-freeze wall hydrant with key lock and combination backflow preventer/vacuum breaker.

C. HOSE BIBBS (HB)

- (1) Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated and as follows:
- (2) Do not install hose bibbs spaces which do not have existing planned or installed floor drains even if sill cocks are indicated for these areas.
- (3) Hose bibbs shall be mounted at eighteen (18) inches above finished floor served.
- (4) The hose bibb shall be Zurn or equivalent similar to the following:
 - a. Zurn Z1350-VB Model. Encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts, replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and 3/4 [19] IP female inlet and 3/4[19] male hose connection standard. Adjustable stainless steel box furnished with hinged cover, cylinder lock and "WATER" stamped on cover. Provide with 3/4 adapter vacuum breaker.

D. 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

E. PRESSURE REDUCING VALVES (PRV)

Install at each location indicated and/or as required to reduce domestic building water service to a maximum of eighty (80) PSIG code approved pressure reducing stations with by-pass. Install in a manner indicated or as required. Provide unions and stops for removal of station. PRV shall be adjustable from thirty (30) percent above or below reduced pressure. Where this cannot be attained with single stage, provide multiphased reduction.

F. REDUCED PRESSURE BACKFLOW PREVENTERS (RPBP)

Watts #909 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 KBC, 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 KBC and as recommended by the roofing manufacturer and/or Contractor.

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 KBC and 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 With Bottle Fillers

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

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. Washer/Dryer Connection Box

Guy Gray Co.
Wolverine Brass, Inc.

L. Wash Fountain

Bradley Co.
Acorn Co.
Intersan
Willoughby

M. P-Trap Insulation Kit (Trap Wrap)

Truebro
Brocar
Plumberex

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 KBC.

2. WATER HEATER

- A. Lochinvar ETA120KK, A.O. Smith or equivalent electric water heater; 120 gallon storage; copper sheathed tin coated elements (75 watt/sq. in. maximum density); glasslined tank; foam insulation; magnesium anode rod; automatic over-heat control; enamelled steel jacket; (2) 4.5 KW elements wired for non-simultaneous operation; upper and lower thermostat; 240/1/60; with ASME temperature and pressure relief valve; set temperature at 105°F.

3. EXPANSION TANK (DOMESTIC WATER)

- A. Amtrol Therm-X-Trol ST-25V expansion tank, 10.3 gallon tank volume, precharged air chamber, stainless steel connection and heavy duty butyl diaphragm.

4. SUMP PUMPS

- A. Weil, Zoeller, or approved equivalent 1-1/4" submersible sump pump, 5 GPM at 24 ft. TDH, 1750 RPM, 1/3 HP, 115 volt single phase. Furnish with mercury switch level control. Provide with light duty iron grate to cover sump pit opening, completely.

5. RECIRCULATING DOMESTIC HOT WATER PUMPS

- A. Thrush, Armstrong, Bell and Gossett or approved equivalent all bronze in-line centrifugal circulating pump with mechanical seals, drip proof motor and all required overloads, starters and disconnects.

END OF SECTION 220300

SECTION 221113 – FACILITY WATER DISTRIBUTION PIPING

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 water-distribution piping and related components outside the building for water service and fire-service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.
- B. DIP: Ductile Iron Pipe

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components. Retain subparagraph below if equipment includes wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
 4. Comply with Ten States Standards, Latest Edition for Potable Water Distribution.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends and flange faces.
 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
1. Notify Architect no fewer than 10 days in advance of proposed interruption of service.
 2. Do not proceed with interruption of water-distribution service without Architect written permission.

1.10 COORDINATION

- A. Coordinate connection to water main with utility owner and operator.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 2. Copper, Pressure-Seal Fittings:
 - 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:
 - 1) Viega; Plumbing & Heating Systems.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - c. NPS 2-1/2 to NPS 4 : Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 2. Copper, Pressure-Seal Fittings:
 - 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:
 - 1) Viega; Plumbing & Heating Systems.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - c. NPS 2-1/2 to NPS 4 : Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated. Pipe shall be coated with a bituminous coating in accordance with ANSI/AWWA C151/A21.51. Interior shall be cement mortar lines and seal coated in compliance with the latest Rev. of ANSI/AWWA C104/A21.4. The cement mortar lining shall be double thickness.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - 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:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company of America.
- B. Flanges: ASME 16.1, Class 250, cast iron.

2.3 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
 - 1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
 - 1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
 - 2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
- C. PVC, AWWA Pipe: AWWA C900, Class 200, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

- a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- b. All mechanical joint fittings where thrust blocking is required will also be secure by joint restrain glands.
6. The use of solvent Cement connections is not allowed.

2.4 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints:

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. EBAA Iron, Inc.
 - b. U.S. Pipe and Foundry Company.
3. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Flexible Expansion Joints:

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:
 - a. EBAA Iron, Inc.
 - b. Hays Fluid Controls; a division of ROMAC Industries Inc.
 - c. Star Pipe Products.
2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig minimum.

C. Ductile-Iron Deflection Fittings:

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:
 - a. EBAA Iron, Inc.

2. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig minimum.

2.5 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8, BCuP Series.
- B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.6 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 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:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - d. Hays Fluid Controls; a division of ROMAC Industries Inc.
 - e. JCM Industries.
 - f. Smith-Blair, Inc.
 - g. Viking Johnson.
 2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.
 - b. Center-Sleeve Material: Stainless steel
 - c. Gasket Material: Natural or synthetic rubber.
 - d. Pressure Rating: 200 psig minimum.
 - e. Metal Component Finish: Corrosion-resistant coating or material.
- C. Split-Sleeve Pipe Couplings:
 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:
 - a. Victaulic Depend-O-Lok.
 2. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

- a. Standard: AWWA C219.
- b. Sleeve Material: Stainless steel.
- c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
- d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
- e. Pressure Rating: 200 psig minimum.
- f. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 250 psig.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 250 psig minimum at 180 deg F
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
 - a. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 250 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
 - a. Description:
 - 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple. complying with ASTM F 1545.
 - 3) Pressure Rating: 250 psig at 225 deg F

- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

2.7 CORROSION-PROTECTION PIPING ENCASUREMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet
3. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
4. Color: Natural

2.8 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

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:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. East Jordan Iron Works, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
 - j. Mueller Co.; Water Products Div.
 - k. NIBCO INC.
 - l. U.S. Pipe and Foundry Company.
2. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 250 psig .
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
3. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 250 psig .
 - 3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate Valves:

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:

- a. American Cast Iron Pipe Co.; American Flow Control Div.
- b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
- e. McWane, Inc.; Kennedy Valve Div.
- f. McWane, Inc.; M & H Valve Company Div.
- g. Mueller Co.; Water Products Div.
- h. NIBCO INC.
- i. U.S. Pipe and Foundry Company.

2. UL/FMG, Nonrising-Stem Gate Valves:

- a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 250 psig.
- 3) End Connections: Flanged.

3. OS&Y, Rising-Stem Gate Valves:

- a. Description: Iron body and bonnet and bronze seating material.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 250 psig.
- 3) End Connections: Flanged.

C. Bronze Gate Valves:

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:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Red-White Valve Corporation.

2.9 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

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:

- a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - b. East Jordan Iron Works, Inc.
 - c. Flowserve.
 - d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - e. McWane, Inc.; Kennedy Valve Div.
 - f. McWane, Inc.; M & H Valve Company Div.
 - g. Mueller Co.; Water Products Div.
 - h. U.S. Pipe and Foundry Company.
2. Description: Sleeve and valve compatible with drilling machine.
- a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter. Valve Box shall comply with KAW requirements.
1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.
- 2.10 CHECK VALVES
- A. AWWA Check Valves:
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:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. APCO Williamette; Valve and Primer Corporation.
 - d. Crane Co.; Crane Valve Group; Crane Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. Mueller Co.; Water Products Div.
 - j. NIBCO INC.
 - k. Watts Water Technologies, Inc.
 2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
 - a. Standard: AWWA C508.
 - b. Pressure Rating: 250 psig

B. UL/FMG, Check Valves:

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:
 - a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - b. Crane Co.; Crane Valve Group; Stockham Div.
 - c. Globe Fire Sprinkler Corporation.
 - d. Kidde Fire Fighting.
 - e. MATCO-NORCA, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. Mueller Co.; Water Products Div.
 - i. NIBCO INC.
 - j. Reliable Automatic Sprinkler Co., Inc.
 - k. Tyco Fire & Building Products.
 - l. United Brass Works, Inc.
 - m. Victaulic Company of America.
 - n. Viking Corporation.
 - o. Watts Water Technologies, Inc.
2. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
 - a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 250 psig

2.11 DETECTOR CHECK VALVES

A. Detector Check Valves:

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:
 - a. Ames Fire & Waterworks; a division of Watts Regulator Co.
 - b. Badger Meter, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Globe Fire Sprinkler Corporation.
 - e. McWane, Inc.; Kennedy Valve Div.
 - f. Mueller Co.; Hersey Meters.
 - g. Victaulic Company of America.
 - h. Viking Corporation.
 - i. Watts Water Technologies, Inc.
2. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
 - a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 250 psig

- c. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
3. Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
- a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 250 psig.

2.12 CORPORATION VALVES

2.13 Manufacturers:

- 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:
 - a. Amcast Industrial Corporation; Lee Brass Co.
 - b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - c. Jones, James Company.
 - d. Master Meter, Inc.
 - e. McDonald, A. Y. Mfg. Co.
 - f. Mueller Co.; Water Products Div.
 - g. Red Hed Manufacturing & Supply.
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
- 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
- 1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.14 WATER METERS

- A. Water meters will be furnished by utility company.

2.15 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Refer to MEP Plan P3.0.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.16 WATER METER BOXES

- A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

2.17 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
 1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
 2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
 - a. Dimension: 24-inch minimum diameter, unless otherwise indicated.

2.18 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

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:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - d. American Foundry Group, Inc.
 - e. East Jordan Iron Works, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. Mueller Co.; Water Products Div.
 - j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
 - k. U.S. Pipe and Foundry Company.
4. Description: Freestanding, with two 4 ½" outlets National Standard Hose Thread, 5-1/4-inch main valve, drain valve, and NPS 8 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve

opening against pressure and closing with pressure. Nut type cap 15/16" square with chains. 18" center of outlet to ground.

- a. Standard: AWWA C502.
 - b. Pressure Rating: 250 psig
 - c. Color: red, and according to LFUCG guidelines.
5. Certify and Service: The following companies have stated that they certify and service privately owned fire hydrants according to NFPA guidelines:
- a. Brown Sprinkler Corporation
 - b. C&C Fire Sprinkler Systems and Inspections
 - c. Central Kentucky sprinkler, Inc.
 - d. Koorsen
 - e. Landmark Sprinkler Corp.
 - f. Simplex/Grinnell
 - g. Kenny Buehler/Private Contractor
 - h. American Fire & Security

2.19 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

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:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire End & Croker Corporation.
 - c. Guardian Fire Equipment, Inc.
 - d. Kidde Fire Fighting.
 - e. Potter Roemer.
 - f. Reliable Automatic Sprinkler Co., Inc.
2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
 - a. Standard: UL 405.
 - b. Connections: Two NPS 2-1/2 inlets and one NPS 6 outlet.
 - c. Finish Including Sleeve: Polished bronze.
 - d. Escutcheon Plate Marking: "AUTO SPKR."
3. Lexington Fire Water Control Office Standards
 - a. Fire Department must be a standalone, 4 1/2" male with National Standard Threads.
 - b. Connection must have strainer and cap.
 - c. The height of the connection should be 17"-19" from the center of the connection to the finished grade.

2.20 ALARM DEVICES

- A. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.
- D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 02300 "Earth moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be any of the following:
 - 1. Soft copper tube, ASTM B 88, Type K copper, pressure-seal fittings; and pressure-sealed joints.
 - 2. PVC, Schedule 40 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
 - 3. Soft copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
 - 4. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.
 - 5. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
 - 6. PVC, Schedule [40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80] socket fittings; and solvent-cemented joints.
- F. Aboveground and Vault Water-Service Piping NPS 3/4 to NPS 3 shall be any of the following:

1. Hard copper tube, ASTM B 88, Type K wrought-copper, solder-joint fittings; and brazed joints.
- G. Aboveground and vault water-service piping NPS 4 to NPS 8 shall be any of the following:
1. Hard copper tube, [ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
- H. Underground Fire-Service-Main Piping NPS 4 to NPS 12 shall be any of the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint grooved joints.
 2. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
 3. Fire service connections and fire hydrants shall have diameters and thread matching KAWC standards.
 4. Fire service connections shall be installed with a metal sign, with one inch raised letters.
- I. Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 12 shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, metal resilient-seated gate valves with valve box.
 2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 3. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising rising stem.
 - b. Check Valves: AWWA C508 UL/FMG, swing type.

3.4 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main. All fittings may not be shown for clarity. It is the contractor's responsibility to include all necessary fittings in their bid. Unless otherwise noted. Bends shall be 45 degrees.
1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
 2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- C. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- D. Bury piping with depth of cover over top at least 30 inches , with top at least 12 inches below level of maximum frost penetration, and according to the following:
 1. Under Driveways: With at least 36 inches cover over top.
 2. In Loose Gravelly Soil and Rock: With at least 12 inches additional bedding.
- E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- H. See Section 15140 "Domestic Water Piping" for potable-water piping inside the building.

3.5 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
 5. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric Fittings for NPS and Smaller: Use dielectric [unions.
 - b. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges []].
 - c. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Bolted flanged joints.
 5. Heat-fused joints.

6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.8 DETECTOR-CHECK VALVE INSTALLATION

- A. Install in vault.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves, meters, shutoff valves, and piping per plans and in accordance with KAW requirements.

3.9 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.

3.10 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.11 VACUUM BREAKER ASSEMBLY INSTALLATION

- A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

3.12 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Refer to MEP plans. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.13 WATER METER BOX INSTALLATION

- A. Install water meter boxes in paved areas flush with surface.
- B. Install water meter boxes in grass or earth areas with top 1/2 inches above surface.

3.14 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.15 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately 2 inches above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.16 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Dry-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. AWWA Fire Hydrants: Comply with AWWA M17.
- D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.17 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.

3.18 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- F. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Section 13852 "Digital, Addressable Fire-Alarm System" and Section 13853 "Zoned (DC Loop) Fire-Alarm System."

3.19 CONNECTIONS

- A. Connect water-distribution piping to interior [domestic water and fire-suppression piping].

3.20 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.21 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.22 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Use purging and disinfecting procedure prescribed by Kentucky American Water.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221313 – FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Nonpressure and pressure couplings.
 - 3. Expansion joints and deflection fittings.
 - 4. Cleanouts.
 - 5. Encasement for piping.
 - 6. Manholes.

1.3 DEFINITIONS

- A. PVC: Poly Vinyl Chloride Pipe.
- B. DIP: Ductile Iron Pipe

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. PVC Pipe and fittings.
 - 2. Ductile Iron Pipe and fittings.
 - 3. Manholes.
 - 4. Elastomeric Sealant
 - 5. Cleanouts
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
- C. Coordination Drawings: Show pipe sizes, locations, and elevations. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- D. Product Certificates: For each type of PVC soil pipe and fitting, from manufacturer.
- E. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than 10 days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS**2.1 PVC PIPE AND FITTINGS**

- A. PVC Type PSM Sewer Piping:
 - 1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- B. PVC Cellular-Core Sewer Piping:
 - 1. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
- C. Gaskets: ASTM F 477, elastomeric seals.
- D. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

2.2 DUCTILE IRON PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Gaskets: AWWA C111, rubber.

2.3 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Mfg.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.
 2. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type, Flexible Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fernco Inc.
 - b. Logan Clay Pipe.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.
 2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
- E. Nonpressure-Type, Rigid Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ANACO-Husky.
 2. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Medium Duty
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required adjusting manhole frame and covering to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 8.75 inch riser, with 4.5 inch minimum-width flange and 25-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 536, Grade 40 ductile or ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 0.6 percent unless otherwise indicated.
 - 2. Install piping 6" and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with 36-inch minimum cover.
 - 4. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
 - 2. Join dissimilar pipe materials with nonpressure-type rigid couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.

- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3" above finished surface elsewhere unless otherwise indicated.
- E. Pipe entering and leaving manholes shall be installed a link seal compression device in accordance with ASTM d-2240, D412, s-395, d-297
- F. Prior to owner acceptance, test manholes according to the requirements of authorities having jurisdiction.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 12" (round) by 12" deep. Set with tops at finished grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 8. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi .
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- C. Connect to grease interceptors specified in Division 2 Section "Interceptors."

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
1. Remove manhole and close open ends of remaining piping.
 2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Division 2 Section "Earthwork."

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
 4. Submit separate report for each test. Retain one of first two subparagraphs below for tests.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
 7. Manholes: Perform hydraulic test according to ASTM C 969
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.11 CLEANING
- A. Clean dirt and superfluous material from interior of piping. Flush with potable water

END OF SECTION 221313

SECTION 230100 - PUMPS

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 specifications which affect the work of this section and which are hereby made a part of the work specified herein.
- B. All required motor starters shall be furnished with the respective pump.
- C. Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard.
- D. Shop drawings shall be submitted as required by Section 200300 and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.
- E. Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.
- F. Insofar as possible, all pumps shall be by the same manufacturer.
- G. Pump shall have data plate indicating horsepower, voltage, phase, ampacity, pressure head, and flow rate.
- H. Special notes for pumps controlled by variable frequency drives:
 - (1) Supplier shall provide the largest non-overloading impeller size for the specified pump motor horsepower, regardless of the specified pump head given on the pump schedule(s).
 - (2) Pumps 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.

2. MATERIAL

A. BASE MOUNTED PUMPS

- (1) Type: Horizontal, base mounted, end suction, single stage, flexible coupled, 175 PSI working pressure.
- (2) Pump Body: Cast iron, flanged gauge and drain tapings, bronze fitted.
- (3) Shaft: Stainless steel. Refer to special notes for pumps controlled by VFD's above for shaft grounding kit specification.
- (4) Bearing: Re-lubricatable ball bearing. Provide insulated bearing journals for pumps greater than 100 HP.
- (5) Seal: Mechanical, carbon ring with ceramic seal.

- (6) Motor: open, drip proof, re-lubricatable ball bearing. Minimum efficiency per NEMA Premium Induction Motor Efficiency.
- (7) Impeller: Enclosed, balanced.
- (8) Base: Structural steel.
- (9) Coupling: Flexible with coupling guard.
- (10) Manufacturers: Subject to compliance with the specified and scheduled requirements. Pumps by the following manufacturers will be considered:

- Armstrong/Aurora
- Bell and Gossett
- Patterson
- Taco
- Paco

(11) SELECTIONS:

Refer to the schedule on the plans for base-mounted pump selections.

END OF SECTION 230100

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 2006, 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: REQUIRED SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.
 - (3) Insure 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 insure 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 video taped.
- (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.
- (10) Equipment incorporating energy recovery wheels shall be provided with an aluminum wheel with molecular sieve desiccant, 4 angstrom maximum sieve size. Wheels shall be certified in accordance with ASHRAE 84 or ARI 1060 standards.
- (11) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.
- (12) Provide low ambient and all required controls and accessories on all HVAC equipment to ensure they can provide cooling during the winter season.
- (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. OUTSIDE AIR UNIT

(1) Casing

Construct casing of 18 ga. minimum mill galvanized or phosphatized steel, dual wall construction, designed to withstand specific operating pressures. Provide casing panels and/or access doors that are easily and quickly removable for inspection and access to internal parts. All welds and drilled holes must be coated.

- (2) Provide single zone unit consisting of draw-thru fan section, hot/chilled water coil section, filter-mixing box, air blender, reheat coil, adjustable fan motor mounting, drain pan, filter frames, and face and by-pass dampers, variable frequency drivers, return and discharge plenums with perforated liners as specified and detailed.
- (3) All fan, filter and access sections shall have airtight hinged and gasketed full size access doors.
- (4) Provide reinforced points of support for either setting or hanging units.

- (5) Provide stainless steel drain pan located under entire coil section extensive enough to catch condensate leaving coil and moisture carry over at the unit operating velocities. Provide drain connection on side of unit. The pan shall be pitched in two planes to insure complete drainage.
- (6) Cover casing and frame with protective finish on all sides.
- (7) Water Coils
 - a. Provide heating/cooling and reheat coils of scheduled capacity, mounted in unit in manner permitting removal.
 - b. Construct coils with copper tubing primary surface and aluminum secondary surface mechanically bonded to tubes by method approved by specified manufacturer.

(8) Fan Section

Provide fans specifically designed and suitable for class or service indicated. Provide adjustable motor base, adjusted with mounting bolts or provide variation in center distance. Provide locking nuts or similar devices to secure base in proper position. Provide belt driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Provide grease lubricated fan bearings with remote externally accessible fittings for lubrication. Statically and dynamically balanced fan assemblies in fan housing after final assembly. Provide flexible connection between fan housing and unit casing.

- (9) Fan motors shall be provided with code approved motor starters. Motor starter shall contain an adjustable time delay relay, adjustable 0-60 seconds.

(10) Insulation

Insulate unit casing from air entrance to fan section, to air outlet from unit. Insulate framing angles exposed to air stream. Securely attach 2" thick, 3# density insulation minimum or of sufficient thickness and density to prevent condensation from forming on unit casing. Protect insulation against deterioration from air currents. Provide insulation with fire-retarding characteristics, complying with ANSI/NFPA 90A. Insulate drain pans as required to prevent condensate formation on unit exterior at ambient conditions to be encountered.

(11) Combination Filter/Mixing Box

Disposable 2" deep extended area filters. Filter media shall have an average efficiency of 25-30% on ASHRAE Test Standard 52-76. Provide air foil, low leak dampers similar to Ruskin CD60.

(12) Vibration Isolators

Provide high efficiency housed spring type vibration isolators to isolate the fan and motor section from the unit casing.

(13) Internal or External Face & By-Pass Dampers

Single section for attachment to unit intake. Provide Ruskin CD-60 opposed blade-type for dampers with nylon bushings for noiseless operation. The contractor shall supply the by-pass duct as required by the manufacturer.

(14) Air Blender

Provide air blender section between filter/mixing box and coil to prevent air stratification entering coil.

(15) Internal Sealing

Seal top of heating/cooling coil and mating surface of F&B damper air tight to prohibit uncontrolled by-pass of air.

(16) Air handling unit shall be Aaon, Desert Aire, Addison, or Semco.

(17) Selection

Refer to the schedule on the plans.

B. WATER TO AIR HEAT PUMPS

(1) General

a. The Contractor shall furnish and install Trane, McQuay (Daikin), Mammoth, JCI, Florida Heat Pump, WaterFurnace or Climate Master heat pumps. Each unit shall be ARI rated and ETL or UL listed. Each unit shall be fully run tested at the factory.

(2) Casing and Cabinet

a. The cabinet shall be fabricated from heavy-gauge galvanized steel and finished with baked-on enamel. The interior shall be insulated with 1/2" thick coated glass fiber. Panels shall provide access to the fan compartment and the compressor/control box compartment. Unit shall have a drain pan with positive slope and a drain connecting extending through the unit casing. Cabinet shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall protrude through the cabinet for connection to a flexible hose. Unit shall be supplied with heavy metal brackets, rubber isolators, fasteners and washers to suspend and isolate the unit from the building structure.

(3) Refrigerant Circuit

- a. Each unit shall have a sealed refrigerant circuit including a hermetic compressor, expansion valve, finned tube heat exchanger, reversing valve, water to refrigerant coaxial heat exchanger and safety controls. Compressor shall have external vibration isolator mounts and thermal overload protection. The finned tube coil shall be constructed of aluminum fins bonded to copper inner tube and a steel outer tube and be UL listed. The heat exchanger shall be rated for 400 PSIG on the water side and 450 PSIG on the refrigerant side.
- b. Safety controls shall include a low suction temperature (freezestat) switch and a high refrigerant pressure switch to lock out the compressor from operation. Units four tons and above shall have a low refrigerant pressure switch for loss of charge protection. A low pressure switch shall not be permitted to replace a low suction temperature switch for freeze protection. Unit shall be able to reset from the BAS. Unit shall be capable of starting in an ambient of 40°F with entering water at 70°F with both air and water flow rates at the ARI rating conditions.

(4) Electrical

- a. A control box shall be located within the unit and shall contain controls for compressor, reversing valve and fan motor operation and shall have transformer and a terminal block for low voltage field wiring connections. Unit shall be nameplated to accept time delay fuses for branch overcurrent protection of the power source.
- b. Unit control system shall provide heating or cooling as required by the setpoints of the wall thermostat. The unit control scheme shall provide for fan operation simultaneous with compressor operation (fan interlock) regardless of the thermostat type.

(5) Fan and Motor Assembly

- a. Unit shall have a direct drive centrifugal fan. The fan housing shall have a removable orifice ring to facilitate fan motor and fan wheel removal. The fan housing shall protrude through the cabinet to facilitate field duct connection. The fan motor shall be multi-speed, PSC type with integral mounting brackets isolated from the fan housing and thermal overload protection. Units above one ton shall have a terminal strip mounted on the fan motor to facilitate motor speed change.
- b. Unit shall have a straight-through or right-angle or opposite-hand discharge air arrangement as indicated on the plans and shall be able to be field converted from one or the other without the use of additional parts.

(6) Control System

- a. Unit shall be supplied with a condensate overflow switch mounted on the drain pan to suspend compressor operation if the pan fills with water. Refer to controls for additional requirements.
- b. Provide drain pan high limit shut off switch.

(7) Flexible Hose

- a. Each unit shall be supplied with three flexible hoses.
- b. Hoses shall be of adequate length for connection to the unit and field piping. Provide hose end adapters for system flushing.

See "STARTUP AND FLUSHING" instructions in this section.

- c. Also refer to "Hose Kit" section of these specifications.

(8) Duct Collar

- a. Provide with duct flange.

(9) Warranty

- a. The unit shall have one (1) year warranty on all parts and labor and a five (5) year parts only warranty on the compressors.

(10) Selection

Refer to the schedule on the plans.

C. HOSE KITS

(1) HOSE KIT SIZES SHALL BE AS SCHEDULED ON THE DRAWINGS.

- a. Provide a factory-assembled, one piece hose kit/piping package for supply and return connections for each heat pump.
- b. Contractor shall provide and install Hays Hose Kit Piping Packages or Nexus Hose Kit Piping packages with integral automatic balance valve. Each kit shall be sized for 2.0 to 7.0 feet per second. Valves may be mounted in any altitude and do not require straight sections of pipe either upstream or down stream for proper operation. Griswold is not an acceptable manufacturer.
- c. Each return side hose kit/piping package shall include the following:
 - 1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2" – 3" shall be constructed of bronze. 4" and larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.
 - 2) Automatic flow control valves shall be factory set to rated flow and shall automatically control the flow to within 10% of the rated value subject to the operating parameters of; 2 to 80 PSID, fluid freezing to 225° F, 2.0 to 7.0 FPS.
 - 3) Valve internal control mechanism shall be of a quiet, clog resistant design with reverse flow capabilities and consist of precision orifice that is field changeable within the listed flow rate.
 - 4) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out proof stems for shut off.
 - 5) Manufacturer shall provide certified independent laboratory tests verifying accuracy of performance.
 - 6) All valves shall be labeled with controlled flow direction, flow rate, PSID control range, manufacturer and model number, unit tagging.
- d. Each supply side hose kit/piping package shall include the following:
 - 1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2-3" shall be constructed of bronze. 4" and larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.
 - 2) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out stems for shut off.
 - 3) Strainer shall be Y-type configuration furnished with hose connector blow down valve. Strainer screen shall be stainless steel mesh and easily accessible for cleaning without disconnecting hoses.
 - 4) All valves shall be labeled with flow direction, manufacturer and model number, unit tagging.
- e. Stainless Steel Braided Supply and Return Hoses: All hoses shall be equipped with end connections at terminal unit. All end connections shall be either permanently crimped swivel

ends or butt welded to carbon steel end fittings to meet stated pressure ratings. Operational temperature shall be rated from fluid freezing to 200 degrees F. Minimum burst pressure shall be four times the working pressure. Furnish with field flushing connection fitting. 1/2" to 1-1/4" shall be reinforced, fire retardant EPDM rubber, bonded to the inside wall of braiding. 1 1/2" and larger shall be a corrugated type 321 stainless steel tube.

- f. Flushing Bypass: Provide with means at each heat pump to flush system completely while allowing no fluid flow through heat pump. Also see "Start-up and Flushing" instructions in this section.
- g. Condensate Hose Kits: Contractors Option: Manufactured 3/4" tubing x 54" long clear flexible plastic hose, with molded P-trap, fittings, couplings and clamps. All condensate drains larger than 3/4" shall be field fabricated by contractor to allow for flexible movement. All sizes shall match sizes indicated on drawings.
- h. Warrantee: Automatic Flow Control Valves containing orifice and diaphragm shall be warranted for the life of the HVAC system in which it was originally installed. Manufacturer shall warrant all other components, for no less than five (5) years from date of purchase. Manufacturer shall warrant steel braided hose for no less than three (3) years from date of substantial completion.

D. 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 used 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

- 2
- a. A minimum of Class 20 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, kWhr, 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 (^oF) 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 voltage (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 arching.
- (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, 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: undervoltage, 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.

E. HYDRONIC SPECIALTIES

(1) Manufacturers

Subject to compliance with the specified and scheduled requirements the following manufacturers will be considered, but not limited to:

Hoffman
Armstrong/Aurora
Bell & Gossett
Patterson
Taco
Victaulic

(2) Air Release Tank

The air release tank shall be of the in-the-pipe-line type with flanged tangential openings for inlet and outlet connections. The inside shall be specifically designed to create a low velocity vortex for the separation of free air from the water stream. The tank shell shall be rated at 125 PSI working pressure and shall be constructed with the ASME code for unfired pressure vessels and shall be so certified and stamped. The tank shall be equipped with a bottom drain connection and expansion tank/vent connection. Tank shall be line sized. Tank shall not have a strainer.

(3) Expansion Tank

The tank shall be constructed in accordance with the ASME Code for unfired pressure vessels and shall be suitable for 125 PSI water working pressure and 340°F maximum water temperature. The tank shall be a pre-charged, heavy duty butyl rubber diaphragm-type pressure vessel complete with standard tire charging valve. Refer to the plans for mounting orientation. Capacities shall be as scheduled on the drawings.

(4) Suction Diffusers

Provide at the inlet of each base mounted pump, a suction diffuser as manufactured by Bell and Gossett, Victaulic, Thrush, or approved equivalent. Each suction diffuser shall be equipped with a disposable fine mesh start-up strainer and an adjustable support foot to carry weight of inlet piping. Victaulic Series 731 G, W731G, Bell and Gossett Suction Diffuser, or equal.

(5) Triple Duty Valves

Provide at the discharge of each base mounted pump and where shown on the plans, a triple duty valve as manufactured by Bell & Gossett, Thrush or Engineer approved equivalent. Each valve shall perform check, shut-off and throttling functions and shall be line sized.

Alternatively, in lieu of a triple duty valve, a Victaulic grooved end "Tri-Service" valve assembly may be used in applicable piping systems. The assembly shall consist of a Victaulic Vic-300 MasterSeal™ butterfly valve with memory stop feature for shut-off and balancing, and a 779 Venturi-Check for backflow prevention and flow measurement.

(6) Flexible Connections

Provide at the inlet and discharge side of each base mounted pump, at each connection to major equipment requiring vibration isolation and where shown on plans, a flexible connector, Metraflex Metrasphere or Engineer approved equal. Flexible connectors shall be of the flexible neoprene and nylon or EPDM and suitable for 225 PSI working pressure and 230°F temperature. Couplings shall be installed per the manufacturer's recommendations, in close proximity to the source of the vibration.

Alternatively, in lieu of a flexible connector, three (3) Victaulic Style 77 flexible couplings may be used on suction side and discharge side of base mounted pumps (six Victaulic flexible couplings per pump).

(7) Pressure Reducing Valve

Provide at the point of connection of the domestic water line to the hydronic system and where shown on the plans, a pressure reducing valve by Thrush, Bell and Gossett, or Engineer approved equivalent. Such pressure reducing shall be provided with an inlet strainer and shall be set to maintain a pressure of 4 PSI in excess of that at the highest point in the hydronic system. Each pressure reducing valves shall be line sized.

(8) Vacuum Breaker

Provide, where shown on the plans, a vacuum breaker as manufactured by Huffman, Jackson or Engineer approved equivalent.

(9) Manual Air Vents

Provide, where shown on the plans, at each rise in piping and where required a manual air vent.

(10) Automatic Air Vents

Provide, where shown on the plans, automatic air vents.

2. 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.

B. At a minimum, the report submitted to the Engineer shall include the following data:

(1) Water Source Heat Pumps

- a. High voltage power supply is correct and accordance with the unit nameplate.
- b. The phasing of the unit is correct per the compressor rotation.
- c. The field wiring and circuit protection is the correct size.
- d. The low voltage control circuit wiring is correct per the unit wiring diagram.
- e. The piping system is clean and complete.
- f. Verify water flow is established and circulating through all units.
- g. The condensate line is properly sized, run, trapped and pitched.
- h. The indoor blower turns freely without rubbing.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note, the items listed below must be verified/checked before the system is put into full operation:

- i. Entering fluid temperature (heat and cool mode)
- j. Leaving fluid temperature (heat and cool mode)
- k. Temperature differential (heat and cool mode)
- l. Return air temperature (heat and cool mode)
- m. Supply air temperature (heat and cool mode)
- n. Water coil heat exchanger (water pressure "in" – psig) (heat and cool mode)
- o. Water coil heat exchanger (water pressure "out" – psig) (heat and cool mode)

- p. Pressure differential (psig) (heat and cool mode)
- q. Compressor amps
- r. Compressor volts
- s. Compressor discharge line temperature (after 10 minutes)
- t. Refrigerant charge (oz.)
- u. Test drain pan operation
- v. Check and note strainer condition.
- w. Check and note filter condition.

(2) Outside Air Units/Energy Recovery Units

- a. Fan rotation
- b. Recovery wheel rotation
- c. Confirm all wiring connections are correct
- d. Confirm all field wiring is correct
- e. Adjust belt tensions and alignments
- f. Confirm pipe connections are correct
- g. Confirm sequence of operation is correct
- h. Confirm damper operation

(3) Base-Mounted Pumps

- a. With power off, note the following:
 - 1) pump properly secured, level, and grouted
 - 2) pipe installed so as not to transmit stress to pump
 - 3) coupler between pump and water shaft aligned
 - 4) pump and motor lubricated
- b. With power on, note the following:
 - 1) impeller rotation
 - 2) Actual amps/volts vs. nameplate amps/volts.
 - 3) Inlet and outlet pressure

3. WATER TREATMENT

A. SCOPE

Provide a one-year water treatment program for the HCS and HPS water loop systems. The one-year period shall start from the date of substantial completion. The program shall minimize corrosion, scaling, and prevent biological fouling of the piping system.

B. QUALIFICATIONS

Chemicals, service, and equipment shall be supplied by a single water treatment company for undivided responsibility. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years, whose major business is in the field of industrial water treatment. The water treatment company shall have regional water analysis laboratories, service department, and full time representatives located within the trading area of the job site or facility.

Water treatment company shall be Bluegrass Kesco, Nalco, American Water Treatment, or approved equal.

C. SERVICE

Provide quarterly field service and Owner consultation. System water or fluid shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition. Provide any laboratory and technical assistance required to achieve a successful program.

D. CHEMICALS

Provide one year's supply of the recommended chemical for scale and corrosion protection of the closed loop recirculating system. If needed, provide separate chemical to control microbiological growth in the system. Formulations shall not contain any ingredients which are harmful to system materials of construction.

E. PHASED PROJECTS

Provide multiple trips, testing, treatment, chemicals, etc. as required to accommodate phased projects. Systems that will be constructed and brought on-line in phases shall be treated at the completion of each phase. Under no circumstance shall any portion of the system operate with untreated heat transfer fluid.

F. EQUIPMENT

(1) Bypass Feeder

Provide one 5 gallon bypass chemical feeder for each system. Neptune DBF-5HP or approved equivalent.

(2) HPS Loop Filter LF-1

Harmsco HIF or WB series fluid filter. Refer to schedule on the drawings for selection. Provide with a total of three sets of filter cartridges.

G. REPORTS

A summary of water or fluid quality and treatment shall be provided in writing to the Owner and Engineer after each quarterly site visit. Results of quarterly biological activity tests shall also be provided to the Owner and Engineer.

4. HEATING/COOLING SYSTEM CLEANING

A. CLEANING AND FLUSHING HYDRONIC HEAT PUMP PIPING SYSTEMS

- (1) During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.
- (2) After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil and any and all other material foreign to the water.
- (3) Before chemical cleaning and sterilization of the entire system, the loop field shall be flushed and purged until free of dirt, debris, and air. During the chemical cleaning and sterilization process the supply and return run-outs shall be temporarily connected together at each heat pump location.

- (4) After purging of the field loop the Contractor shall add an approved system cleaning solution at the recommended concentration to the entire system. Circulate the system with cleaner for the time recommended by the chemical manufacturer. After prescribed circulation time, flush the system until cleaner is removed.
- (5) After chemical cleaning, the entire system shall be sterilized. Introduce a solution of sodium hypochlorite to achieve a chlorine residual of 25 to 50 ppm. Maintain this chlorine level for 12 to 24 hours. Flush out system until chlorine residual in system equals that of the makeup water.
- (6) After the system has been completely cleaned and sterilized as specified herein, the individual heat pumps shall be connected permanently to the supply and return runouts and the system filled for operation under normal closed loop conditions. Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

5. 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 school 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.

Here is a list of things you should not do:

- (1) Do not prop the exterior doors open during construction or while moving in furnishings.
- (2) Do not start all of the units until students are starting school. When students start school the normal setpoints, schedules, and fan cycling shall begin.

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, AND DIFFUSERS

1. REGISTERS, GRILLES AND DIFFUSERS

A. GENERAL

Alternate R, G & D selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price, Titus, Metalaire, Anemostat, and Kruegar. 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.

2. DIFFUSERS FOR RAISED FLOOR AND ACCESSIBLE FLOOR SYSTEMS

- A. Provide floor mounted supply diffusers as required to distribute supply air CFM of air handling equipment scheduled to serve raised/accessible floor areas. Coordinate placement of diffusers in the room with manufacturer of equipment to be set in the room. Diffusers shall be manufactured specifically for raised floor applications and shall support foot traffic and equipment. At the Contractor's option, diffusers may be supplied by the accessible floor system manufacturer; it is emphasized, however, that the Contractor is finally responsible for providing a finished air distribution system for the raised/accessible floor system.

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.

2. PRESSURE VENTS

- A. Provide a pressure relief vent in the supply air ductwork at each air handling unit. It shall be located between the fan outlet and the first manual or automatic (i.e., fire, fire smoke, or any motorized) damper or closure device. It shall be sized to relieve the duct air pressure below the rated pressure construction of the ductwork and above the working pressure of the fan. Provide a vacuum relief vent in the return and/or outside air ductwork at each air handling unit. It shall be located between the air handling unit casing and the first manual or automatic damper or closure device. It shall be sized to relieve the duct vacuum below the rated construction of the ductwork and above the working negative pressure of the fan. Automatic fan shutdown upon damper closure shall not be an acceptable protection for either overpressure or vacuum conditions. All duct relief dampers shall be of the automatic resetting type unless otherwise noted.

3. FILTER RACKS

- A. 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.

4. WALL PENETRATIONS

- A. 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.

5. PROTECTION DURING CONSTRUCTION

- A. All ductwork openings shall be covered during construction 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. The Contractor shall pay for duct cleaning if precautionary measures are not taken.

6. LOW VELOCITY DUCTWORK

- A. General (Low Velocity)

- (1) Double turning vanes shall be installed in all square turns and in any other locations indicated.
- (2) Provide "spin-in" type fittings for all round ducts serving supply air diffusers where the duct branches off the rectangular duct main. The spin-in fitting shall not penetrate farther than 40% into the duct width.
- (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.
- (7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. 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 perlins 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., shall be sealed. Seal with "Duct Seal 321". Apply per manufacturer's recommendations.
- (10) Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.
- (11) 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.
- (12) 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.
- (13) 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.

- (14) 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.
- (15) Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.
- (16) All fans and other vibrating equipment shall be suspended by independent vibration isolators.

B. Materials (Low Velocity)

- (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.
 - b. Exposed ductwork in finished spaces 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 IMC and SMACNA HVAC Duct Construction Standards - Metal and Flexible, or as follows whichever is more stringent.

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

- (3) 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.

C. Miscellaneous (Low Velocity)

- (1) 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 velocity ducts secured with snap lock.
- (2) Turning Vanes: Barber-Colman, Titus, Waterloo, or equivalent; fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.
- (3) 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.
- (4) Access Doors; In Ductwork: In ducts where indicated or where required for serving equipment, fabricated according to SMACNA recommendations and be equivalent to those manufactured by Air Balance, Vent Products or other approved equivalent. 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. 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.
- (5) Access Doors; In Ceilings or Walls: Titus, Krueger, Milcor or approved equivalent with key locks.
 - a. In mechanical, electrical or service spaces. 14 gauge aluminum brushed satin finish, 1" border.
 - b. In finished areas.
14 gauge primed steel with 1" border. To accept the architectural finishes specified for the space.

Provide where required to access equipment, dampers, valves, filters, etc.
- (6) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air volume dampers. Frames shall be 4" x 1 "x 16 gauge galvanized steel. Blades shall be 16 gauge galvanized steel, maximum of 6" wide. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.
- (7) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air Round Damper. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20 gauge steel, 7" long. Damper blades shall be 20 gauge galvanized steel. Axle shall be 3/8" diameter steel. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.
- (8) 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.

7. HIGH VELOCITY DUCTWORK

A. Application (High Velocity)

- (1) All Variable Air Volume system supply ductwork between the air handling unit and all Variable Air Volume terminals shall be high velocity double wall ductwork. Branch supply takeoffs serving single Variable Air Volume terminals shall be permitted to be high velocity single wall ductwork.
- (2) All Constant Air Volume system supply ductwork in a system utilizing Constant Air Volume boxes shall be high velocity double wall ductwork between the air handling unit and the Constant Air Volume boxes. Branch supply takeoffs serving single Constant Air Volume boxes shall be permitted to be high velocity single wall ductwork.

B. General (High Velocity)

- (1) 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) Duct dimensions indicated are required inside clear dimensions.
- (3) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with Hardcast "DT" tape and Hardcast "RTA-50" adhesive installed in strict accordance with manufacturers recommendations.
- (4) Ductwork shall be installed per SMACNA Medium or High Pressure Manual, whichever is applicable. (Latest Edition shall apply.)
- (5) 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.
- (6) 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.
- (7) 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.

C. Materials (High Velocity Single Wall)

- (1) All round and oval high velocity ductwork shall be United McGill "Uni-Seal" or "Uni-Weld" ductwork or Semco, Dixie, Eastern Sheet Metal, Langdon, or approved equivalent as required by pressure rating of the system.
- (2) Ductwork shall be spiral, lock-seam type and be constructed of galvanized steel.

DIAMETER (Or Equivalent Round Diameter For Oval Ducts)	METAL THICKNESS
3-14 Inches	26 Ga.
15-26 Inches	24 Ga.
27-36 Inches	22 Ga.
37-50 Inches	20 Ga.
52-60 Inches	18 Ga.

All duct fittings shall be fabricated by duct manufacturer. Duct fittings shall be minimum 20 gauge. All fittings shall be a minimum of one gauge heavier than the pipe size.

D. Air Leakage Testing of the Ductwork Systems

- (1) It is the intent of this section to insure the ductwork installed has minimal air leakage.
- (2) Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test & Balance specifications.
- (3) It is the intent to test all ductwork. The duct systems which will require testing are as follows:
 - a. All exhaust air duct systems.
 - b. All make-up air duct systems.
- (4) Do not insulate the supply air systems prior to testing.
- (5) The maximum allowable supply air leakage rate is 2.5% of the systems design CFM when the ductwork is pressurized to 2.5" WG (Therefore, if a supply air system is tested, and the supply air fan rated capacity is 10,000 CFM, the allowable leakage is 250 CFM.) The maximum allowable return air and exhaust air leakage rate is 2.5% of the system design when the ductwork is pressurized to 1.50" WG.
- (6) The entire supply air ductwork system shall be tested with some exceptions. On VAV systems, the high velocity ductwork upstream of the VAV boxes shall only be tested. Cap the duct at the inlet to the VAV box. On low velocity reheat system, all ductwork upstream of the hot water reheat coil shall be tested. The air volume damper and access door upstream of the reheat coil shall be included in the tested system.
- (7) 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 prior to the flex duct. 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.

- (8) The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following:
 - a. All ductwork as described in above paragraphs.
 - b. Access doors
 - c. Volume dampers
 - d. Fire dampers
 - e. End caps used to seal ducts
- (9) 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 allowance at no additional cost to the owner.
- (10) 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.
- (11) A duct pre-installation conference shall be held prior to the installation of the ductwork. Present should be the owner's representative, engineer, Test & Balance Contractor, General Contractor, Mechanical Contractor, Sheet Metal Contractor, Insulation Contractor and the manufacturer's representative of the duct sealant to be used. At this meeting, the contractor shall advise all of the duct materials and sealant materials to be used to meet the air leakage allowances.
- (12) 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 250200 - CONTROLS – DIRECT DIGITAL

1. LOCAL DIRECT DIGITAL CONTROL (DDC) NETWORK

- A. HVAC systems and components, including field-modified controls, shall use BACnet protocol for DDC communication. Equipment that is not native BACnet and requires a communication gateway is not permissible without written authorization from the Owner.
- B. Network controllers shall have a minimum of 10% extra points available for future buildings needs without having to add expansion blocks. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.

2. INTEGRATION WITH EXISTING FRONT-END SERVER

- A. Contractor shall provide full integration of local DDC network with Owner's existing off-site front-end server. Integration to existing front-end shall be performed by manufacturer's authorized technician ("Integrator"), either
 - 1. Automated Logic
 - 2. Trane
- B. Integration shall include the installation of all software patches applicable to the existing version of the front-end server.
- C. The browser-based graphical user interface (GUI) shall meet or exceed most recent building in functionality and appearance. Operators shall be able to perform all normal operator functions through the GUI. The "homepage" graphic shall be updated with link to new building. User access privileges shall be configured per Owner's requirements.
- D. Graphics generation software shall be provided to allow the Owner to add, modify or delete system graphic displays, if not already licensed to the Owner. Use of proprietary graphic file formats are not be acceptable. Screen graphics shall be no larger than 960 x 720 pixels without Owner consent.
- E. The primary graphic for the building will be the floor plan. Color graphic floor plan displays will be generated by importing AutoCAD floor plan drawings from Engineer. Each floor plan display will provide, at minimum, the outdoor air temperature and a color coded indicator of individual zone condition. Each floor plan graphic shall provide links to detailed schematics of respective mechanical equipment. Graphic linking and detail penetration shall be accomplished with the pointing device without the need for menu access for keyboard entry.
- F. The front-end server shall directly control HVAC equipment as specified in the contract documents. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.
- G. All equipment shall continue to function as last programmed or in default mode if communication with the front-end server is lost.
- H. All network points shall use naming conventions established by equipment/controller literature, typically the BACnet parameter name specified in the technical manual. The front-end server is

intended to provide remote control of the building. All network points with write capability shall be configurable via the GUI.

- I. All labor, material and software necessary to meet the functional intent of the system shall be included. Equipment and labor not specifically referred to herein or on the plans, that is required to meet the functional intent, shall be provided without additional cost to the owner.
- J. No systems or components that require a yearly licensing renewal fee to operate shall be permitted.
- K. Integrator shall work with Owner's IT department to secure open ports and IP addresses.

3. DATABASE MANAGEMENT

- A. The front-end server will read/write data to an external database maintained by the Owner.
- B. Integrator will work with Owner's IT department to develop an Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant database for all system database parameter storage. Systems requiring proprietary database and user interface programs are not acceptable.
- C. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture are not acceptable.
- D. The Integrator should use good judgment with regards to sampling interval to reduce the size of the database. Unless otherwise noted, trend points shall use the following default sampling interval:

Every 5 minutes:

Temperature, setpoint, RH, CO2, flow, pressure, position, percent (%)

On Change of Value (COV):

Status, stage, mode, enable, occupancy, index, alarm, adjustment, override

- E. The system shall automatically delete trend data older than two years.

4. FRONT-END REDUNDANCY

5. SOFTWARE UPGRADE

- A. Include as Alternate the cost to upgrade existing front-end server to most recent software version.

6. WORKSTATION

- A. Contractor to provide one desktop computer workstation and monitor including all software and hardware required to fully access the remote front-end server. The workstation shall have the ability to access all data using a standard web browser and add-ons without requiring proprietary operator interface and configuration programs.
- B. The workstation shall contain the processor speed, memory and storage capacities necessary to use the front-end server per manufacture's recommendations. The operating system must be compliant with the Owner's network and security requirements.

7. OWNERSHIP

- A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. All software licensing shall be made to the Owner, not the Contractor or vender, or installer with all tools in, all tools out functionality and such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All software shall be capable of adding other manufacturer licensed vendors if of the same firmware. All project developed software, control software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

8. FRONT-END TRAINING

- A. Integrator shall train Owner's maintenance personnel to adjust, operate, and maintain control systems and components using front-end GUI. Include a minimum of 8 hours dedicated instructor time. At Owner's request, unused time shall be made available to answer ad hoc questions and/or make programming changes to the front-end server.
- B. The Owner's operator training and instructional program shall address, at a minimum, the following topics:

- Overview of the system architecture and unit level controllers
- System logon/logoff procedures
- Adjust setpoints and override process
- Configure and respond to alarms
- Make schedule changes
- Monitor and command objects and properties
- Utilize and set up trends
- Generate and save reports
- Point list naming convention by reference to equipment technical manuals

9. DELIVERABLES

- A. At time of Controls Submittal, Integrator shall provide Owner with sample graphic for each equipment type. More than one graphic should be provided if alternate format/images are available.
- B. Prior to substantial completion, Equipment supplier(s) shall provide Owner with technical manuals in PDF format for each equipment type that document available I/O network points and their respective configuration. Unavailable I/O points must be clearly denoted.
- C. At substantial completion, Integrator shall provide pathname of front-end server folder(s) necessary for full backup recovery of building configuration. The contents of the folder(s) must be sufficient to restart the system in the event that the front-end server requires re-installation.
- D. Contractor to provide Functional Review & Verification report.

10. 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. 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. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.
- G. 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.
- H. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.
- I. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.
- J. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the KBC and IMC Section 606.
- K. 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.
- L. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.
- M. 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.
- N. 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).
- O. 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 in conduit. All electrical work specified under this division of the specifications shall also comply with Division 26 of these specifications.

- P. All exterior electrical work, equipment, etc. shall be waterproofed.

11. 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. Controls Contractor is to participate in equipment startup concurrently with the equipment supplier starting up the equipment.
- (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. This is to be done at both the integrator and equipment level.
 - (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.
 - d. To be done at both the equipment and integrator level.

12. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Control System Checkout and Testing. Provide Engineer with log documenting completion of startup tests. Submission of log is required before Demonstration and Acceptance may begin. Demonstration is to be done both orally and remotely.
- (1) Engineer will be present to observe and review system demonstration. Schedule with Engineer at least 14 days before system demonstration begins. Systems balancing shall be complete prior to demonstration, coordinate scheduling with TAB agency accordingly.
 - (2) Demonstrate actual field operation of each sequence of operation as specified in these specifications. Provide at least two persons for two days each (32 man hours) to demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Specified on site time does NOT include time necessary to correct deficiencies.
 - (3) Demonstrate complete operation of operator interface.

- (4) Demonstrate all alarms, including external alarms to Owner selected pagers, phones, e-mail accounts, etc. Also demonstrate fire alarm system interface.
- (5) Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
- (6) Provide all required tools to perform system demonstration and point calibration (drills, duct plugs, thermometers, hygrometers, hand-held carbon dioxide sensors, aerosol test smoke, 2-way radios, water probes, DP sensors for water and air, etc.)
- (7) Provide a technician to be able to accomplish all of the commissioning agent's requirements.

B. Acceptance.

- (1) After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
- (2) System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in these specifications. Warranty will not start until acceptance by Owner and Engineer.

11. WARRANTY PERIOD REVIEW

- 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. 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. Coordinate training with requirements in the front end documents. THIS IS TO CORRELATE WITH THE OPPOSED SEASON TESTING BY THE COMMISSIONING AGENT.
- 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.

13. ONE YEAR OPTIMIZATION PERIOD

- A. The controls contractor shall provide assistance to the Engineer for a period of one year from date of system acceptance for the purposes of optimizing the systems for energy efficiency and occupant comfort. The assistance shall consist of the following:
 - (1) Assist the Engineer in accessing the controls system remotely.
 - (2) Input schedules and setpoints for all zones and equipment as requested by Engineer and Owner.
 - (3) Trend points as requested by Engineer.
 - (4) Modify controls sequences as requested by Engineer. No additional points will be added by the Engineer.
 - (5) Modify setpoints and schedules as requested by Engineer and Owner.

Additionally during the optimization period, include 2 site visits (6 hours on-site each) for system modifications that cannot be accomplished remotely. This is to correlate with the opposed season testing by the commissioning agent.

14. 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 digital display of zone temp, setpoint, mode, and occupancy. 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.
- c. The thermostat shall have no integral thermometer.
- d. All thermostats provided for the project shall be similar in size and appearance.
- e. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
- f. 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.

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.

15. 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 _____

16. SEQUENCE OF CONTROL

- A. See plans.

END OF SECTION 250200

SECTION 250300 – AIR QUALITY MONITORING SYSTEM

1. GENERAL

- A. Drawings and general provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification Sections, apply to this Section. The following work shall be bid as an Allowance.

2. OVERVIEW

- A. This document contains the specification and input/output summaries for a Facility Monitoring System (MS). The system architecture shall utilize local room sensors, duct and outside air probes networked to distributed Air Data Routers and Sensors Suites communicating over a data and air sampling network. The air sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to distributed Sensor Suites located throughout the facility. The air sampling network shall consist of intelligent air packet routers, an electrically conductive micro duct network, and structured cable. Gathering of air samples shall occur via room, duct mounted, and outside air sampling sensors and probes located as indicated in the documents. The MS shall provide continuous monitoring of environmental conditions as prescribed in the Sensor Suite section, and provide protected access via a web based user interface to analytical summaries in onscreen and report form. The MS shall interface with other analog and microprocessor based building subsystems as shown on the drawings, specified herein and in other sections.

3. RELATED SECTIONS

- A. 3rd-Party Interfacing is required on this project according to the following Specification sections for sub-systems:

(1) Section 250200 – Controls

B. REFERENCES

- (1) ANSI/ASHRAE 135-2001: BACnet™ - A Data Communication Protocol for Building Automation Systems: This shall include the Standard and all published Addenda.

4. DEFINITIONS

- A. **MS** refers to the Facility Management System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; or ATC, Automatic Temperature Control. BAS Building Automation System.)
- B. **FMC** refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications.
- C. **MS** refers to the hardware, software and other components comprising the Facility Monitoring System as herein described.
- D. **I/O** refers to Input/Output. Thus, "I/O device" means "Input/Output device".

5. ACCEPTABLE FACILITY MONITORING SYSTEM CONTRACTOR (FMC)

- A. The FMC shall have support services within a 120 mile radius of Project Site and comply with the service requirements of a 24 hour response time. Support services is defined as having complete parts inventory, having all required test and diagnostic equipment, and have trained technicians on the systems specified herein.

6. CONTRACTOR RESPONSIBILITIES:

- A. The FMC shall furnish all necessary hardware, wiring, structured cable, tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent and as defined in this specification.
- B. Installation of all MS components; and all electrical work required as an integral part of this section as noted in Part 5.0 Execution including but not limited to Sensor Suites, Air Data Routers, Room Sensors, Duct Probes, Transformers, Vacuum Pumps, Information Management Servers, Structured Cable, etc., shall be by the MS supplier.
- C. A separate proposal shall be furnished to the owner by the FMC at the time of the bid noting all annual service costs for the sensors in the Sensor Suite; including sensor element replacement, calibration, warranty, and diagnostic services as specified in Part 12-Sensor Proposal.

7. SYSTEM REQUIREMENTS

- A. All material and equipment used shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.
- B. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
- C. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

8. EQUIPMENT

A. System Hardware

- (1) The FMC shall provide the following:
 - a. All Air Data Routers, Sensor Suites, Sensor Suite Sensors, Room Sensors, Duct Probes, Outside Air Probes Information Management Servers, Vacuum Pumps, Structured Cable, transformers, required to perform the functions listed.
- (2) System Software
 - a. The FMC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the FMC, including point descriptors, test sequences, reports and point summaries. The FMC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
 - b. The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS.
- (3) Building Ethernet Connection Cabling:
 - a. Provide CAT-5e or CAT-6 cabling and installation between the Information Management Server and the owner's Building Ethernet Connection. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.
- (4) Codes and Regulations

- a. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
 - 1) Occupational Safety and Health Act (OSHA)
 - 2) National Electric Code (NEC)
 - 3) National Fire Code
 - b. All Air Data Routers and Sensor Suites shall be listed per:
 - 1) Underwriters Laboratories UL916 for Open Energy Management
 - c. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.
- (5) The control system manufacturer shall have quality control procedures for design and manufacture of facility monitoring systems for precision monitoring, indoor air quality, energy savings and preventative maintenance.
 - (6) The FMC shall provide all test area attribute data and programming and shall coordinate object naming conventions and network map requirements with the owner's internal BAS department. The naming convention shall be submitted with the FMC Shop Drawings for review and approval by owner's BAS department.

9. SUBMITTALS

- A. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies. This version shall be transmitted in electronic format, via e-mail, to expedite the approval process.
- B. Shop Drawings shall include:
 - (1) Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
 - (2) Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
 - (3) Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each Air Data Router and Sensor Suite. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems.
 - (4) Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with a reference-document. The addressing scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
 - (5) Equipment Numbering: Equipment numbering scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
 - (6) Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
 - (7) System Schematic: Drawings shall include a single-line representation of all areas being monitored and/or controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.

- (8) Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, routers, sensor suites, controllers, panel devices, wiring terminal numbers and any special information (i.e. shielding requirements) for properly monitoring areas and controlling equipment.
- (9) Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation.
- (10) Configuration Details: Drawings shall include test and cluster sequence schedules for each test point.
- (11) As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. As-Built Drawings will be acknowledged in writing by the project design engineer and the owner's representative after the final checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The FMC shall provide four sets of As-Built Drawings.

C. Operating and Maintenance Manuals

- (1) Operating and Maintenance (O&M) manuals for the system shall include project specific, detailed information describing the specific installation. Manual shall contain as a minimum:
 - a. System overview
 - b. Networking architecture
 - c. Established test sequences and cluster schedules
 - d. Hardware cut-sheets and product descriptions
 - e. Wiring diagrams for all controllers and field hardware
 - f. Installation, mounting and connection details for all field hardware and accessories
 - g. Commissioning and setup parameters for all field hardware
 - h. Maintenance procedures, including final tuning and calibration parameters

10. CONTRACTOR (FMC) EXPERIENCE AND PERFORMANCE

- (1) The FMC shall have a local office or representative, staffed with factory trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The FMC shall be responsible for replacement of all products supplied at all times for a period of not less than 1 year following project completion, and shall provide a **24** hour response to a service/warranty call from the owner.

11. WARRANTY

- A. Repair or replace any defective product and correct any defect in material or workmanship for a period of 12 months following the date of acceptance of the system.

12. SENSOR PROPOSAL

- A. A proposal shall be furnished to the owner at the time of the bid noting all annual service costs for the sensors and sensor elements to be provided within the Sensor Suite; and all costs to insure

their ongoing performance. The proposal shall detail all costs for sensor element replacement, calibration services, diagnostics, software upgrades, materials and equipment necessary for ongoing sensor operation. As a minimum, twice a year, provide calibration with NIST approved calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This services shall include, but not be limited to the following:

- (1) Provide a factory certified depot to remove all sensors within the sensor suite on a periodic basis (as a minimum, twice per year), and replace with pre-packaged, certified, industry traceable, factory calibrated sensors. Removed sensors shall be returned to the FMC for factory recalibration, upgrades, sensor element replacement, and component and board repairs. Written records shall be provided to the owner for every visit indicating the performance of such calibrations along with all pertinent data.
- (2) All costs for the repair and replacement of any defective sensor, and for any consumable element or part on the sensor shall be included.
- (3) All system software upgrades to correct bugs, fixes and patches for the sensors shall be included.

13. AIR DATA ROUTERS

- A. The Air Data Router shall be furnished as a complete, self contained, unit housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.
- B. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all the other solenoid valves in the system. A direct path between the test area and the virtual sensors located with the Sensor Suite shall be established to draw a continuous stream of air through the Structured Cable.
- C. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable connections; a communications/processor board; high capacity solenoid valves; and sampling manifold.
- D. Air Data Router shall have provisions to interface to the MS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.
- E. Air Data Routers shall be capable of sampling of up to four test areas. Air Data Routers shall be sized and configured with the appropriate number of air sampling solenoid valves including all hardware and software to accommodate the number of test areas noted on the plans and/or specifications.
- F. Air Data Router shall have the capacity to sense per test area the temperature at the room, duct or outside air via a room temperature sensor, duct probe, or outside air probe. A total of four sensor inputs shall be provided that corresponds to the air sampling of the respective four test areas.
- G. Air Data router shall be capable of accepting universal 0-10v and 4-20mA inputs and outputs through expansion boards for interfacing to other third party devices and controllers.
- H. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.

- I. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Information Management Server. Each Air Data Router shall contain both software and firmware to receive and perform full test sequencing schemes downloaded from the Server.
- J. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network interrogation shall be possible through this port.
- K. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
- L. Air Data Routers shall have LED indication for visual status of communication and power.
- M. Air Data Routers shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite that serves the Air Data Router. Low voltage power shall be distributed to the Air Date Routers through the associated structured cable.

14. SENSOR SUITE

- A. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self contained unit housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
- B. The Sensor Suite shall provide communications between the Air Data Router sub network and the Information Management Server over an isolated RS-485 network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.
- C. The Sensor Suite base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Structured Cable connections; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
- D. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. As a minimum, the Sensor Suite shall be incorporate the following sensors to meet the required applications:
 - (1) CO2 based Demand Controlled Ventilation (DCV) or Monitoring. CO2 sensor to be Dual wavelength, non-dispersive infrared, range 0-3000 PPM; accuracy +/-75 PPM; repeatability +/- 9 PPM; response time 10 seconds.
- E. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service. Additional, modular sensor bay expansion capabilities shall be provided for additional sensors.
- F. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.
- G. On-board diagnostics shall continuously perform system checks.
- H. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network interrogation shall be possible through this port.
- I. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
- J. Sensor Suites shall have LED indication for visual status of communication and power.

- K. Sensor Suites shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite provided by the FMC. Transformer shall also distribute low voltage power to the Air Data Routers connected to the Sensor Suite through the associated structured cable.

15. INFORMATION MANAGEMENT SERVER

- A. The Information Management Server (Server) shall provide network management of Sensor Suites, integration to the BAS, and interface to the web based Air Monitoring System for viewing and outputting graphs, charts and data derived from the Facility Monitoring System.
- B. The hardware platform for the Server shall, at a minimum, consist of:
- (1) PC processor with minimum 64-bit word structure.
 - (2) Minimum 2.4 GHz processor speed.
 - (3) Minimum 4.0 GB on board RAM
 - (4) Hard drive or equal high-speed data storage, minimum 80 GB.
 - (5) Network Interface Card: (10/100)
 - (6) RS-232 Serial Port
 - (7) Operating System shall be Windows XP.
- C. The Contractor shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server's Network Interface Card and the owner's Building Ethernet Connection.
- D. The Server shall be located within 25 feet of the nearest Sensor Suite and be connected to the Server through the RS-232 serial port.

16. STRUCTURED CABLE

- A. The MS shall utilize a pre-engineered system of Structured Cable to facilitate network wide communications; distribution of low voltage power to Air Data Routers and Sensor Suites; and provide a sampling conduit for air samples all within a single cable.
- B. The cable shall consist of a plurality of wires to distribute communications, data and low voltage power throughout the MS. As a minimum, Structured cable shall consist of:
- (1) Communications – 22 AWG twisted shield pair with drain wire
 - (2) Low Voltage Power – 18 AWG, 3 wire
- C. An inner pathway, MicroDuct, shall be furnished as an integral part of the Structured Cable to facilitate collection of test area air samples. MicroDuct shall be lined with a smooth, electrically conductive, chemically inert surface to insure air samples remain pure and uncorrupted and do not adhere to the wall lining during transport. Aircuity OSC or stainless steel tubing only. No exceptions. Polyethylene tubing, copper tubing, galvanized pipe are not acceptable. See below for stainless steel specifications.
- D. Structured cable shall not require any specialized tools for installation. Installation of the cable shall follow traditional local area network practices.

- E. Structured cable shall be suitable for riser and plenum applications, be Underwriter's Laboratories Listed to UL CMP and C-UL CMP standards, and carry the appropriate markings throughout the cable length.

17. ROOM SENSORS/DUCT PROBES

A. Room Sensors:

- (1) A semi-flush mounted, room temperature sensor with an integral air sampling port are to be housed within one enclosure; the port within the enclosure will accept the MicroDuct from the Structured Cable.
- (2) Internal coarse filter to screen out large particulate from entering the MicroDuct.
- (3) Terminations:
 - a. Sensor – one wire
 - b. Power – three wire
 - c. MicroDuct – integral hose clamp
- (4) Option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.

B. Duct Probe – Duct and Outdoor Air Mount

- (1) A duct temperature sensor and air sample probe is to be mounted within one enclosure. Duct sample probe to accept integral MicroDuct from Structured Cable.
- (2) Internal coarse filter to screen out large particulate from entering the MicroDuct.
- (3) Terminations:
 - a. Sensor – one wire
 - b. Power – three wire
 - c. MicroDuct – speed fitting
- (4) Option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.
- (5) Outdoor Air Locations – A NEMA 4X weatherproof enclosure shall be provided.

18. SYSTEM SOFTWARE OVERVIEW

- A. The FMC shall provide all software required for operation of the MS system specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:
 - (1) Completed database.
 - (2) Configuration of all Air Data Router, Sensor Suite, Server and user interface application programs.

- (3) All Configuration Tools, and all software licenses, required to configure and operate all products installed on this project.

19. SYSTEM CONFIGURATION

- A. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through the Information Management Server.
- B. The system shall permit the operator to perform, as a minimum, the following:
 - (1) Add and delete points/objects
 - (2) Modify point parameters
 - (3) Create and modify control sequences and programs
 - (4) Reconfigure application programs

20. WEB BASED USER INTERFACE AND DATA MANAGEMENT SYSTEM

- A. Included with the system shall be a fully integrated web based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all test areas for online viewing and reporting.
- B. Unlimited data access, viewing, report generation and remote data storage shall be provided with the MS for the duration of the project commissioning and for the entire warranty period.

21. TEST SEQUENCING

- A. The system shall allow the operator to designate any test area to be scheduled with an operator command through the Information Management Server.
- B. The operator shall be able to make all schedule additions, modifications and deletions to the test schedules. The operator shall have the capability to edit all schedules and then download any or all schedule changes to the MS.

22. EXECUTION

- A. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the MS.
- B. Install software in Air Data Routers, Sensor Suites and Server. Implement all features of programs to specified requirements and as appropriate for sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.

23. WIRING INSTALLATION

- A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.

- B. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 section and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
- C. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.
- D. Install wiring and cables according to Division 26 section and as follows:
 - (1) Bundle and harness multi-conductor cable in place of single cables where several cables follow a common path.
 - (2) Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
- E. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. All other wiring shall be installed neatly and inconspicuously.
- F. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

24. CONTROL DEVICE INSTALLATION

- A. All room sensors and shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings.
- B. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.
- C. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 1" between the enclosure and the wall.
- D. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.
- E. Mounting height shall be a maximum 6'-6" to the top of the enclosure.
- F. A field-installed, 14-gage galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

25. CONTROL POWER

- A. Provide power for Air Data Routers, Sensor Suites, Server and associated MS components from nearest electrical control panel noted below or as indicated on the electrical drawings—coordinate with Electrical Contractor.
 - (1) Power supply for Air Data Routers, Sensor Suites, Server and associated MS components shall be connected via a dedicated circuit to the building normal electrical distribution panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system.

- (2) Power supply for Air Data Routers, Sensor Suites, Server and associated MS components serving critical spaces (i.e. Animal Rooms, Computer Server Rooms, Research Spaces, Archives, Storage Vaults, etc.) shall be connected via a dedicated circuit to the building emergency distribution panel.

26. IDENTIFICATION

- A. The FMC shall label each system device with a point address or other clearly identifiable notation inside the device cover - labels shall be permanent. All MS equipment shall be clearly identified as noted on the approved submittals.

27. ACCEPTANCE OF COMPLETED MS INSTALLATION

- A. Upon completion of the installation, the FMC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the FMC in the presence of the design engineer, job site project manager, and owner's representative. Acceptance test shall be scheduled with at least 10 working days advance notice. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.
- B. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
- C. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- D. The acceptance test shall include, but not be limited to:
 - (1) The FMC shall verify the proper operation of all input/outputs.
 - (2) The FMC shall verify all inputs meet or exceed manufacturer's stated tolerances for accuracy.
 - (3) The FMC shall verify that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
 - (4) The FMC shall verify the reliability of all communications of all Air Data Routers and Sensor Suites.
 - (5) The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.
- E. Acceptance: When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner's representative and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the owner's representative and the warranty period shall start.

28. TRAINING

- A. The FMC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

- B. Training shall include a minimum of one 8 hour session at substantial completion and another 8 hour session to be scheduled during the first year of building occupancy.
- C. Instructions shall include 2 parts, the "New Equipment Orientation" and the "Product Training".
- D. New Equipment Orientation: A "walk-through" session shall include showing where all field equipment is located throughout the area involved in the project.
- E. Product Training: Train technical services and maintenance personnel on-site to adjust, operate, and maintain the MS. As a minimum:
 - (1) Train personnel on procedures and schedules for starting and stopping test sequences, troubleshooting, servicing, and maintaining equipment.
 - (2) Provide operator training on modification of data display, test area descriptors, executing commands, resetting default values, and requesting reports.

END OF SECTION 250300

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 labor 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, licensed to provide such services in the Commonwealth of Kentucky. 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.

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 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.
- 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 and 27 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.

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, insure 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 \$125.00 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 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			
Switchgear			
Branch Panels			
Feeder Conduit			
Branch Conduit			
Feeder Wire			
Branch Wiring			
Emergency Generator			
Fire Alarm Conduit & Wiring			
Fire Alarm Devices			
Cabletray & Accessories			
Light Fixture Interior			
Light Fixture Exterior			

Lighting Control System			
Wiring Devices			
Surge Suppression			
Chemical Grounding System			
Intercom/Paging Conduit			
Intercom/Paging Wiring			
Intercom/Paging Devices			
CCTV System Conduit			
CCTV System Wiring			
CCTV System Devices			
Intrusion Detection Conduit			
Intrusion Detection Wiring			
Intrusion Detection Controller & Devices			
Voice/Data System Conduit			
Voice/Data System Wiring			
Voice/Data System Devices & Termination			
Audio/Video System Conduit			
Audio/Video System Wiring			
Audio/Video System Devices & Termination			
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 switchgear, panels, disconnect switches, fuses, transformers, contactors, starters, etc.
- C. Fault Current Coordination Study.
- D. All wiring devices and device plates.
- E. All light fixtures and lamps.
- F. Emergency generator.
- 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.
- I. Security intrusion detection system.
- J. Lightning protection system.
- K. Voice/Data wiring system.
- L. CATV wiring and distribution system.
- M. Paging/Intercom distribution system.
- N. Fire alarm system.
- O. Wireless sound enhancement system.
- P. All necessary coordination with electric utility company, telephone company, cable television company, etc. to insure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
- Q. Paying all necessary fees and cost for permits, inspections, work by utility companies(power, telephone, CATV, etc). The Contractor shall contact the utility companies prior to submitting a bid to determine exactly these charges will be.

- R. 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.

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 switchgear & panelboards).
- Switchgear and panelboards.
- Circuit breakers or fusible switches, per each type.
- Power and lighting contactors.

- Disconnect switches.
- Fuses, per each type required.
- Magnetic starters, if not submitted with unit equipment by supplier.
- Control components (relays, timers, selector switches, pilots, etc.)
- Building service grounding electrode components.
- Metering devices.
- Bus duct and each type of fitting for bus duct.
- Emergency generator, engine fuel system and transfer switch, with all required generator system accessories, such as battery charger, batteries, exhaust system and its insulation, fuel pumps, day tanks, etc.
- Transient voltage surge suppression system.
- Grounding system.

Raceways

- Cable tray and each type of cable tray fitting.
- Surface-mounted metal or plastic raceways, with each type of fitting.
- J-hook or Bridle ring assemblies.

Devices

- Each type of wiring device and their coverplates.
- Floor boxes, each by type, with required accessories.
- 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.
- Lamps, each by type.
- Ballast, each by type.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.

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.
- Closed circuit television security system.
- Intrusion detection system.
- Building paging/intercom audio system.
- Telephone system.
- Video system.
- Data network.
- Sound reinforcement system(s).

- Wireless intercom system.

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.
- Manholes, hand holes, and all outdoor electrical equipment and fittings.

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 Commonwealth's Department of Housing, Buildings and Construction or other governing authority for their review. No work shall be done until drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

4. MAINTENANCE AND OPERATION MANUALS

- A. Upon 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 pipe sizes 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 24 gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" 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.
- I. 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 260504

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 insure 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 effected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

- A. Connection of Telecommunications (voice, video, data) lines to Owner's existing or new services.
- B. Connection of Power lines to Owner's existing or new services.
- C. Connection of fuel oil and exhaust piping to emergency generator and furnishing of fuel for testing unit. Provide a full tank at final acceptance.
- D. Connection of all controls to equipment.

- E. Electrical power connections to electrically operated (or controlled) equipment.
- F. 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.

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.
- (8) No aluminum conductors shall be used.

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. Where conductors are installed in industrial facilities, they shall be per J.I.C. standards.
 - G. 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.
 - H. 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.
 - I. Where multiwire branch circuits are allowed, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.
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
 - (2) 277/480 Volt Conductors
 - Phase A - Brown

Phase B - Orange
Phase C - Yellow
Neutral – Solid Gray or White with tracer stripe to match phase conductor

- (3) Isolated Power Conductors (Type XLP or XHHN)
 - Phase A – Brown with colored stripe other than white, green or grey
 - Phase B Device or Neutral- Orange with colored stripe other than white, green or grey
 - Phase C - Yellow with colored stripe other than white, green or grey
 - Neutral on Three-Phase Systems- 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.

- (4) Control Wiring - Red, or as indicated.
- (5) 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.
- (6) 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 thermally 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, ten 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.

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. Where lightning protection systems are utilized on the work, their electrodes and conductors shall be electrically segregated from the building service ground, except where connections to structural elements are required for the proper installation of these systems. Lightning protection grounds shall only be utilized for lightning grounding applications, in accord with U.L. and manufacturer's recommendations.
 - K. Grounding connections shall **never** be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.
 - L. Where dielectric fittings are utilized in piping systems, the piping system shall **not** be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall not be utilized as ground paths except where specifically required by codes in the case of water piping.
4. GROUNDING ELECTRODE SYSTEM
- A. The ground electrode system shall be as specified herein. The system shall not require maintenance throughout the expected life span of the materials.
 - B. Ground system shall be an electrolytic rod type, as manufactured by Lyncole XIT Grounding, Superior Grounding Systems, L.E.C., Inc. (Chem-Rod), or approved equivalent. Electrode(s) shall be placed as shown on the plans, installed exactly per manufacturer's recommendations. Electrodes shall be installed vertically, 12 feet of overall length (or length as indicated), set in a drilled hole and backfilled per manufacturer's instructions with a special clay slurry surrounding the rod. Provide a concrete protection box with cast iron grate for the top of the rod termination. Ground system shall be per the following:

- (1) Manufacturer: Lyncole XIT Grounding (or approved equivalent).
- (2) Source: Lyncole XIT Grounding, 22412 S. Normandie Ave., Torrance, CA 90502 1-800-962-2610
- (3) Shaft Configuration: Straight.
- (4) Shaft Length: 12 feet (or as otherwise indicated).
- (5) Listings: U.L.-467J, ANSI 633.8.
- (6) Material: Type K Copper.
- (7) Construction: Hollow tube, 2.125" O.D., chemical filled with non-hazardous metallic salts.
- (8) Weight 3.5 lbs. per foot of length, nominal.
- (9) Ground Wire Termination: Exothermic ("Cadweld" by Contractor) connection to 4/0 conductor, with U-bolt with pressure plate provided as test point.
- (10) Average Life Expectancy: 25 Years.
- (11) Model Number: K2-(length)CS.
- (12) Provide grounding system with the following components: protective box, backfill material. Box to be concrete with cast iron, tamper-resistant lid, backfill to be "Bentonite" clay.

C. Installation of Pipe Ground System

- (1) **Pipe ground systems shall be installed exactly as required by the system manufacturer. The Contractor shall be diligent to observe the excavation, sealing tape removal, slurry backfill and all other critical requirements.**
- (2) **Note: NEVER USE SAND OR ORDINARY EARTH AS A BACKFILL MATERIAL**

- D. Pipe grounding system shall be warranted unconditionally by the Contractor for a period of one year from the date of substantial completion.

5. GROUND TESTING PROCEDURE

- A. The actual resistance to earth of the service grounding electrode shall be measured by the Contractor via the fall-of-potential method. This testing shall be accomplished after the grounding electrode has been completely installed and the finished grade is achieved.
- B. The results of the testing shall be summarized in a written report by the Contractor, which shall be forwarded to the Engineer for review. The report shall also be included with the operation and maintenance manuals for the Owner's information and future reference. This report is to also contain a detailed description and illustrations of the testing procedure, along with the name and model number of the testing instrument(s).
- C. For the actual testing, the Contractor shall follow the procedures outlined below. A self-contained instrument such as a "Megger" or "Ground OHMMETER" shall be used that is designed to eliminate the influence of stray current effects on the accuracy of the measurements.
 - (1) Connect one side of the instrument to the grounding electrode conductor where it connects to the facility main ground bus (point C1). Disconnect and isolate the grounding electrode conductor for the test.
 - (2) Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.
 - (3) Drive the movable grounding probe (C3) into earth at ten equally spaced intervals, in a straight line between C1 and C2 points and note the $E/I=R$ resistance readings on a graph at each point.

- (4) The resistance measurements in OHMS taken from the flat part of the curve shall be averaged to determine the true grounding electrode resistance to earth.
- (5) At completion of testing, remove reference electrode C2 and all temporary wiring and connections.
- (6) If actual measurements of grounding electrode indicate a resistance greater than five OHMS, contact the Engineer for instructions. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential achieved.

END OF SECTION 260526

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 2" above top of backsplash
T.V. Outlets.....	1'-6"
T.V. Outlets - At Wall Brackets	7'-2"
Desk Telephones.....	1'-6"
Wall-Mounted Telephone.....	4'-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 AND 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) Surface metal raceways.
 - (9) Wireways, wall ducts and trench ducts.
 - (10) Cable tray or cable trough.
 - (11) Duct banks, and their construction.
- 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.

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.

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. SURFACE METAL RACEWAYS

- (1) Surface metal raceways shall be constructed of code gauge corrosion-resistant galvanized steel or aluminum extrusions, and finished in an ivory, buff or grey color as selected by the Architect. Finishes shall be suitable for field painting, prepared by the installing contractor as necessary.
- (2) Surface metal raceways, where used as raceways only, shall be sized for the conductors indicated. Nominal minimum size of such raceways shall be equivalent to Wiremold Co. Series #700, or equivalent by Isotrol or other approved manufacturer.
- (3) Surface metal raceways to be furnished with integral receptacles shall have Simplex Nema 5-20R outlets spaced on centers as indicated on plans. These shall be Wiremold Co. #2200 Series or equivalent Isotrol or other approved manufacturer.
- (4) Surface metal raceways and all components and fittings shall be furnished by a single manufacturer, wherever practical. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc, necessary for a complete installation shall be provided by the installing contractor. These raceways shall be rigidly mounted with approved fasteners on not to exceed 24" centers in a run, or 6" from ends and on either side of a corner. Refer to plans for notations on exact types of these raceways and outlet configurations.

I. WIREWAYS, WALL DUCT, FLUSH FLOOR TRENCH DUCT

(1) WIREWAYS

- a. Wireways of painted steel construction shall be corrosion-resistant, moisture and oil resistant where indicated or necessary. Wireways shall be furnished in nominal sizes of 2 1/2" X 2 1/2", 4" X 4", 6" X 6", 8" X 8" or 12" X 12", as indicated on plans. Furnish with hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.
- b. Provide wireways with hangers of same manufacturer, installed so as to allow unobstructed access to wireway interior. Install at not to exceed 8'-0" centers, closer as needed at fittings

and turns. Use 1/4" rod hangers minimum for up to 4"X4", 3/8" rod minimum up to 8"X8", 1/2" rod minimum for 12" X 12".

- c. Wireways shall be equivalent to Square "D" Co. "LD" series, as a minimum standard of construction and quality.

(2) WALL DUCTS

- a. Where wall duct type raceways are indicated to be installed flush, they shall be a minimum 3 1/2" deep by 10" wide (or 18" width, as indicated), furnished with screw covers to overlap flange 1" on each side. Covers shall be furnished in nominal 3'-0" lengths. Provide fully grommeted openings or bushed nipples as needed in coverplates to pass cables thru. Where indicated or required, provide transition fittings between horizontal runs of wireway and wall ducts to properly interface each raceway system.
- b. Where wall ducts are installed flush either vertically or horizontally as a collector duct, provide proper blocking and support in stud walls, adding a layer of studs as needed to prevent undercutting major structural elements of walls. Trim flange shall be set tight to wall surface with 1/16" tolerance each way.
- c. Wall ducts, if indicated to be surface mounted, shall be furnished with flangeless coverplates.
- d. All completed systems shall be provided with a factory prime painted finish, suitable for field finish painting.
- e. Wall ducts shall be equivalent to Square D Company "RWT" Series, as a standard of construction and quality.

(3) TRENCH DUCTS

- a. Trench duct is to be installed flush with finished concrete floor slab with a vertical tolerance to adjacent surfaces of 1/16" plus or minus. Nominal depth of trench duct shall be adjustable from 2 3/8" to 3 1/2", minimum 12" width unless otherwise noted on plans.
- b. Trench duct shall be constructed of code-gauge steel, 14 gauge minimum, with corrosion resistant finish. Surfaces of duct or fittings in contact with concrete shall be painted with two coats of "Asphaltum" or receive equivalent coating or taping prior to placement of concrete.
- c. Furnish trench duct with flat turns, riser transition fittings to wall duct or panelboard as shown, concrete tight couplings, internal barriers as required to separate services, reducers, end closers, tees and all other fittings as indicated or required.
- d. Furnish coverplates of aluminum, 1/4" thickness minimum, with flush fasteners in nominal 24" lengths. Furnish grommeted openings or nipples with insulated bushings as required. Coverplates shall not deflect more than .085" with application of a 200 pound concentrated load. Any compartment over 16" in width shall have additional coverplate support, to meet the deflection criteria above.
- e. Provide (as standard) an aluminum tile trim flange (verify and coordinate with floor finishes). Refer to architectural drawings, where applicable.
- f. Trench duct and coverplates shall be equivalent to Square "D" Company RSV/RCP-AL series, as a standard of quality and construction.

J. CABLE TRAY OR CABLE TROUGH

- (1) Cable tray shall be furnished in all-aluminum construction or galvanized steel construction, as noted and sized on the drawings.
- (2) Galvanized finishes on tray shall be hot-dipped after fabrication for all trays in exterior locations. Mill finished galvanizing may be used where tray is installed indoors in dry locations.
- (3) The installing contractor shall carefully follow the manufacturer's recommendations for hanger sizing and hanger support spacing. The weight per linear foot of tray, fully loaded with a 200% safety factor shall be accounted for in sizing hangers. Refer to manufacturer's instructions and/or the drawings, as applicable for hangers and supports. In no case shall supports be spaced further than 8'-0" apart.
- (4) Cable tray shall be of the ladder type with rungs spaced 12" apart. Side rails shall be of I-Beam or C-Channel construction with welded rungs, depth and width as indicated on the drawings.
- (5) Cable trough shall be similar to cable tray, except bottom shall be a ribbed solid piece, depth and width as indicated on the drawings.
- (6) Cable tray or trough shall be provided with all required fittings for a complete installation. Fittings shall include, but not be limited to: Horizontal and vertical elbows and tees, smooth dropout fittings, end closure plates, fixed (or adjustable) splices as needed for field offsets, reducers, barriers or box connector flanges.
- (7) Cable tray and trough shall be equivalent to Square "D" Company Series CLA/CLG (ladder tray) or CTA/CTG (trough) as a standard of quality and construction.

K. 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 4" x 8", 12", and 18 inches.
- 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: 8 inches
 - 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.

L. DUCT BANKS

- (1) Duct banks are defined as a raceway or raceways installed in underground locations, enclosed in a steel-reinforced concrete envelope. They shall be installed where indicated on the drawings or otherwise required.

- (2) All concrete used in duct bank construction shall be 3000 PSI minimum 28 day compressive strength unless otherwise noted, in accord with latest A.C.I. standards. Testing of concrete shall be the responsibility of the Contractor, as directed by the engineer. Place concrete against undisturbed earth, or provide forming as needed.
- (3) Duct bank raceways shall receive a minimum of 3" concrete cover all sides. Minimum size of any duct bank shall be 12" x 12" square, in cross section. In all cases, local and national codes shall apply to duct bank construction where they exceed the requirements of this specification.
- (4) Each corner of duct bank shall receive a minimum No. 4 steel reinforcing bar with 2" minimum concrete cover on all sides. Lap bars fifteen diameters at all splices. Provide stirrup bars bury 60" on center to tie bars together. Stirrups may be #3 bar. Reinforcing steel shall be rigidly supported during pour and vibration, and shall be constructed to ASTM standards.
- (5) Support for encased raceways shall be as recommended by raceway manufacturer, spaced 8'-0" maximum on centers, rigidly fastened to prevent floating of ducts during concrete pours. Supports shall be of a material compatible with the raceway, and shall be of the interlocking type, forming a rigidly braced installation. Provide base type and intermediate type spacers to suit conduit configurations and sizes.
- (6) Where rigid nonmetallic raceways leave concrete duct banks, a transition to rigid steel conduit shall be made 18" inside the concrete envelope. Under no circumstances shall PVC, EB or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and dowel duct bank rebars 4" into manhole wall with non-shrink grout. Refer to details on drawings, as applicable. Slope all raceways within duct bank systems such that they shall drain into manholes or pull boxes. Provide proper drainage at manholes or pull boxes to prevent water accumulation.
- (7) Where ducts transition thru manholes, pull boxes or at terminating end, each duct shall be specifically identified. A nomenclature as shown on the drawings or as agreed upon by the installer and engineer shall be utilized to identify each individual duct. A permanent means of identifying each duct, such as engraved lamacoid plates or stamped metal tags shall be used.

M. 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 required, raceway fittings shall be provided in explosion-proof configurations rated for the atmosphere. Place conduit seal off fittings at each device in accord with applicable codes. Seal off fittings shall be packed with wadding, and poured with an approved non-shrink sealing compound.
- (3) 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.
- (4) 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.

- (5) 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.
- (6) 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.
- (7) Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
- (8) 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.
- (9) Indentation or die-cast fittings shall not be permitted in any raceway system.
- (10) 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.

N. SUPPORTS AND HANGERS

- (1) Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion - resistant, galvanized or furnished with an equivalent protective coating. All electrical raceways shall be hung independently from the building structure with U.L. listed and approved materials. Hangers and supports depending from the support systems of other trades work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.
- (2) No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.
- (3) Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.
- (4) The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.
- (5) Individual conduits run on building walls or equipment shall be secured by one hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.
- (6) Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb tee clamps, flange clamps, beam clamps, "minerallacs", etc.

- (7) Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth, 12 gauge. Utilize conduit clamps appropriate to the channel.
- (8) Channel strut systems for supporting electrical equipment or raceways in outdoor wet or corrosive locations shall be constructed of 12 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent. In indoor dry locations, factory finish paint will be acceptable.
- (9) The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.
- (10) Welding directly on conduit or fittings is not permitted.
- (11) Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.
- (12) Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.
- (13) Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

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 or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits containing primary power conductors, (higher than 600 volts to ground) shall be 42" to top below finished grade, unless otherwise noted on plans.
 - 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. 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:

PANEL "XYZ" FED FROM "MDP - 2" 120/ 208/ 3PH/ 4W - 225A BLACK-RED-BLUE CONDUCTORS

- D. Where branch circuit panelboards and switchgear are connected to an emergency source, the lamacoid plate shall be red, and the word "emergency" shall be incorporated into the legend. Also provide similar plates and legends for automatic transfer switches, and equipment disconnects 100 amps and larger.
- 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.
- 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.

END OF SECTION 260553

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.
- C. Commissioning Plan and Appendices.

1.02 SUMMARY

- A. Section includes commissioning process requirements for Conveying Systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 010800 - General Commissioning Requirements
 - 2. Section 010801 - Functional Testing
 - 3. Section 017900 - Demonstration and Training
 - 4. Select Division 26 equipment specifications

1.03 SYSTEMS COMMISSIONED

- A. Lighting
- B. Lighting Controls
- C. Emergency Generator
- D. Manual Transfer Switches

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Attend Construction Phase Commissioning Conference as part of Commissioning Team.
- B. Attend commissioning progress meetings as scheduled by Commissioning Authority.
- C. Respond to all Issues Tracking Log items identified by Commissioning Team within one (1) week of notification.
- D. Review and accept Functional Testing Procedures as prepared by Commissioning Authority.
- E. Perform functional testing as directed by the Commissioning Authority.
- F. Support Owner contracted functional testing as directed by Commissioning Authority.
- G. Perform seasonal functional testing as required by test procedures.
- H. Provide Electrical systems, assemblies, equipment, and component maintenance orientation and training as described in specifications.
- I. Provide information requested by the Commissioning Authority for final commissioning documentation.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Review submittals for commissioned equipment against the Owner's Project Requirements.

- B. Provide project-specific Construction Checklists and Functional Tests for actual Electrical Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- C. Verify a sample of systems, assemblies, equipment, and component Construction Checklists.
- D. Observe equipment start-up of the generator.
- E. Witness a sample of systems, assemblies, equipment, and component functional testing executed by Contractor
- F. Compile test data, inspection reports, and certificates in Commissioning Report.
- G. Compile information into a project Systems Manual.
- H. Coordinate Owner Training
- I. Complete an 11 and 18 Month Warranty Phase review of system operations.

1.06 LIGHTING CONTROL CONTRACTOR'S RESPONSIBILITIES

- A. Due to the impact the Lighting Controls System has on the success of functional testing, the following supplemental requirements shall apply.
- B. Project specific responsibilities of Lighting Controls Contractor:
 - 1. Provide a written plan to the Commissioning Authority and Architect / Engineer describing process for completing checkout and start-up of Lighting Controls System.
 - 2. Provide resources to facilitate Functional Testing of Lighting and Daylighting Systems, assemblies, equipment, and components including but not limited to technicians, any necessary unique instruments for verifying photometric readings, and passwords for lighting control system interfaces.

1.07 COMMISSIONING SUBMITTALS

- A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.
- B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.
 - 1. Lighting Controls System Point-to-Point Check
 - 2. Grounding Study
 - 3. Conductivity Test Results

1.08 COMMISSIONING DOCUMENTATION

- A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:
 - 1. Process and schedule for completing Construction Checklists for Electrical Systems, assemblies, equipment, and components to be verified and tested.
 - 2. Construction Checklists for review and approval by Commissioning Authority and Architect / Engineer.
- B. In addition to the requirements detailed in applicable Division 26 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report and Systems Manual:
 - 1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 2. Test and inspection reports and certificates.
 - 3. Construction Checklists results.
 - 4. Completed Functional Test procedures.
 - 5. Responses to corrective action documents.
 - 6. Final version of the Basis of Design

7. System single-line diagrams
8. As-built sequences of operations, control drawings, and original setpoints
9. Operations and Maintenance manuals for commissioned equipment
10. A record of Owner training sessions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS PREPARATION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.02 CONSTRUCTION CHECKLISTS EXECUTION

- A. Refer to Section 010800 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

- A. Refer to Section 010801 - Functional Testing for complete procedures and requirements.

3.04 GENERAL FUNCTIONAL TESTING REQUIREMENTS

- A. Refer to Section 010801 - Functional Testing for complete procedures and requirements.

3.05 FUNCTIONAL TEST EXECUTION

- A. Refer to Section 010801 - Functional Testing for description of tasks to complete for this project.

3.06 POST ACCEPTANCE PERIOD

- A. Refer to Section 010801 - Functional Testing for complete seasonal or deferred testing procedures and requirements.

3.07 OWNER TRAINING

- A. Refer to Section 017900 - Demonstration and Training for Owner Training requirements for this project.

END OF SECTION 260800

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. MAIN SWITCHBOARD - CIRCUIT BREAKER STYLE

- A. Switchboard shall be dead front, totally enclosed, free standing or wall mounted, as required or herein specified, housing the equipment as indicated. The switchboard shall meet Underwriters' Laboratories enclosure requirements, and be furnished with an Underwriters' Laboratories label. The entire switchboard is to be Square D I-Line or equivalent construction, G.E., Siemens, Eaton / Cutler - Hammer or approved equivalent. Where switchboards are floor-mounted, provide concrete housekeeping pad, 3" high, with #4 rebar on 6" X 6" centers, per A.C.I. standards. Chamfer edges of pad 1/2".
- B. The switchboard shall be dead-front with front accessibility. The switchboard framework shall consist of steel channels bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed of code gauge steel, rigidly welded together to support all cover plate, bussing and component devices. All unused positions shall have closures.
- C. Each switchboard section shall have an open bottom (closed for wall-mounted style) and a top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway front covers shall be secured by screws and hinged, to permit access to the branch circuit breaker load side terminals. The paint finish shall be medium light gray, per ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment. Enclosure shall be NEMA 1, with drip shield on top. Provide top covers without knockouts. All conduit entries to be field cut. At top conduit entries, provide weatherproof sealing lock nuts on terminator.
- D. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Main and/or through busses shall be 100% annealed copper. The through bus shall have an ampacity in amperes as indicated on the drawings and shall be braced to have a short circuit current rating of 100,000 RMS symmetrical amperes unless otherwise indicated. (Where through bus is provided, it shall have provisions for the addition of future sections on the branch or distribution side.) The through bus supports, connections and joints are to be bolted with hex head bolts and belleville washers to minimize maintenance requirements.
- E. Neutral bussing shall be of the same ampacity bussing and insulated from the enclosure. Ground bussing shall be sized and shall be bonded to the enclosure per N.E.C., current edition. Service grounding electrode connection shall be made between ground and neutral busses. Provide ground bushings and equipment ground conductor connection on each feeder conduit leaving switchboard and at the terminal end for each continuous metallic feeder conduit.
- F. Each switchboard, as a complete unit, shall be given a single short circuit current rating by the manufacturer. Such a rating shall be established by actual tests by the manufacturer, in accordance with UL specifications, on equipment constructed similarly to the subject switchboard.
- G. The service disconnect device(s) shall be thermal-magnetic molded case circuit breaker(s) installed totally front accessible and front connectable. Line side of branch circuit breaker connections are to

be jaw type plug-on. Ground fault protection shall be provided as required by N.E.C. Article 230-95, where circuit breaker frame sizes are 1000 amperes or greater, regardless of trip setting.

- H. Group mounted molded case circuit breakers for branch distribution are to be totally front accessible. These circuit breakers are to be mounted in the switchboard to permit installation, maintenance and testing without reaching over any line side bussing. All line and load side connections are to be individual to each circuit breaker. Common mounting brackets or electrical bus connectors will not be acceptable. Line side circuit breaker connections are to be jaw type plug-on, arranged to withstand the anticipated fault currents.
 - I. Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate as well as exercise the circuit breaker operating mechanisms.
 - J. Include power factor, kw, kwh, voltage, amperage, metering per phase along with appropriate digital output to interface with campus DDC control system for remote monitoring of power system. Coordinate with controls supplier for a 100% complete installation, provide bacnet gateway.
 - K. All circuit breakers shall have a minimum ISCA rating of 65,000 amps, A.I.C., unless otherwise noted on the drawings.
 - L. Arc Flash Hazard warning labels shall be affixed to all switchboards in accordance with Article 110.16 of the National Electrical Code.
 - M. Switchboard shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
 - N. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.
3. DISTRIBUTION PANELBOARDS (600 AMPERE OR GREATER)
- A. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge steel, with gray baked enamel finish electrodeposited over cleaned, phosphatized steel.
 - B. The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Bus structure shall be full height of panel.
 - C. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C. rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All panelboards unless otherwise noted shall have space to accept forty-two 20 amp one pole circuit breakers.
 - D. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly

shown by the breaker handle taking a position between "ON" and "OFF." Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. All panelboards shall be capable of accepting 225 amp 3 pole branch breakers as a minimum unless otherwise noted.

- E. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on schedules on the plans or as determined by verification with local utility company. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.
- F. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code.
- G. Distribution panelboards shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- H. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

4. 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.
- M. Panels shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- N. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

5. 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.

6. 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.
- G. Switches shall be as manufactured by Square D., G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.

7. FUSES

- A. Upon completion of the building, the Contractor shall provide the owner with spare fuses as shown below. All fuses shall be Bussmann, Shawmut, Gould or Reliance.
 - (1) 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares:
 - (2) Bussmann spare fuse cabinets - Catalog No. SFC - shall be provided to store the above spares.
- B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.
- C. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes R.M.S. symmetrical. The fuses shall be UL Class L.
- D. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284°F melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of 10 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. The fuses shall be UL Class RK1.
- E. Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately 125% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element

Fuses LPN-RK (250 volts) or LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

- F. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

8. 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.

9. COORDINATED POWER SYSTEMS PROTECTION

A. General

- (1) Analyses shall be prepared to demonstrate that the equipment selected and systems constructed meet the contract requirements for rating, coordination, and protection. They shall

include a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 3 years.

- (2) The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.
- (3) The time-current characteristics, features and nameplate data for each existing protective device shall be determined and documented. Contractor shall coordinate with AEP for fault current availability at the site.
- (4) A single line diagram shall be prepared to show to the electrical system buses, devices, transformation points and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

B. FAULT CURRENT ANALYSIS

- (1) The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.
- (2) Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.
- (3) Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.
- (4) The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device rating and settings; situation where system coordination is not achievable due to device limitation (an analysis of and device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

C. STUDY REPORT

- (1) The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- (2) The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

- (3) The report shall document (utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings).
- (4) The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.
- (5) The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer and version number shall be provided.

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 125V, 15A	NEMA 5-20R NEMA 5-15R	! !	HUBBELL CR5362 * GE 5362 * 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 PREMIUM GRADE	125V, 20A 125V, 15A	NEMA 5-20R NEMA 5-15R	! !	HUBBELL 5352 * LEVITON 5362 * GE 5362, * HUBBELL 5252 ** LEVITON 5262 ** GE 5262 **
* USE WHERE ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHERE ON DEDICATED 15A CKT., OR WHERE 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

RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER- RESISTANT SCREWS)	125V, 15A	NEMA 5-15R	!	HUBBELL HBL- 8200-SG
RECEPTACLE, DUPLEX NEON PILOT FACE-RED	125V, 15A	NEMA 5-15R	!	HUBBELL 5262-LHR GE 5362-LHR LEVITON 5362-LHR
RECEPTACLE, SIMPLEX WITH CLOCK HANGER TAB, STAINLESS STEEL PLATE	125V, 15A	NEMA 5-15R	METAL	HUBBELL 5235 LEVITON 658-BR ARROW-HART 5760
RECEPTACLE, DUPLEX ISOLATED GROUND (WITH ORANGE LEGEND PLATE)	125V, 20A	NEMA 5-20R	ORANG E	HUBBELL IG-5362 GE 5362-IG LEVITON 5362-IG
RECEPTACLE, DUPLEX HOSPITAL GRADE (TO BE USED IN ALL PATIENT CARE AREAS, PER N.E.C., ART. 517)	125V, 20A	NEMA 5-15R NEMA 5-20R	!	HUBBELL 8200H GE 8200 LEVITON 8200 HUBBELL 8200H GE 8300 LEVITON 8300
RECEPTACLE, DUPLEX RED COLOR NYLON FACE (FOR EMERGENCY POWER OUTLETS)	125V, 20A	NEMA 5-20R	RED	HUBBELL 5352-RDB GE 5362-RDB LEVITON 5362-RDB
RECEPTACLE, DUPLEX ISOLATED GROUND WITH SURGE SUPPRESSION, INCLUDING INDICATOR LIGHT	125V, 15A	NEMA 5-15R	BLUE DEVICE	HUBBELL 5250S LEVITON 5380 ARROW-HART 5362
RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 GE 4124 LEVITON 5032
RECEPTACLE, SINGLE	250V, 30A	NEMA 6-30R	BLACK	HUBBELL 9330 GE 4139 LEVITON 5372
RECEPTACLE, SINGLE	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367 GE 4141 LEVITON 5374

SWITCH, SINGLE POLE	120/277V, 20A	SPST	!	HUBBELL HBL-1221 GE 5951 LEVITON 1221
SWITCH, SINGLE POLE - RED TOGGLE (WITH RED COVER PLATE, FOR EMERGENCY LIGHTING CONTROL)	120/277V, 20A	SPST	RED	HUBBELL HBL- 1221-RDB GE 5951-RDB LEVITON 1221-RDB
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	!	HUBBELL HBL-1223 GE 5953 LEVITON 5953
SWITCH, FOUR-WAY	120/277V, 20A	4-WAY	!	HUBBELL HBL-1224 GE 5954 LEVITON 5954
SWITCH, KEYED	120/277V, 20A	SPST	N/A	HUBBELL HBL- 1221-L GE 5951-L LEVITON 1221-L
SWITCH, KEYED	120/277V, 20A	3-WAY	N/A	HUBBELL HBL- 1223-L GE 5953-L LEVITON 1223-L
SWITCH, KEYED	120/277V, 20A	4-WAY	N/A	HUBBELL HBL- 1224-L GE 5954-L LEVITON 1224-L
<u>NOTE:</u>				
SWITCH, KEYED TO <u>EACH</u> BE FURNISHED WITH ONE HUBBELL #1209 KEY. TURN OVER TO OWNER AT CLOSE OF PROJECT AND OBTAIN RECEIPT FOR VERIFICATION THAT KEYS HAVE BEEN DELIVERED.				
SWITCH, MOMENTARY, 3-POSITION, CENTER OFF SWITCH, PILOT (TOGGLE LIT IN OFF POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT	!	HUBBELL HBL SERIES GE EQUIVALENT LEVITON EQUIVALENT
SWITCH, PILOT (TOGGLE LIT IN OFF POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT OR AS NOTED	CLEAR "LEXAN"	HUBBELL HBL SERIES GE EQUIVALENT LEVITON EQUIVALENT

SWITCH, PILOT (TOGGLE LIT IN ON POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPST OR AS NOTED	CLEAR "LEXAN"	HUBBELL HBL-PL7 SERIES GE EQUIVALENT LEVITON EQUIVALENT
TIMER SWITCH	120V	SPST, 15 MINUTE	!	NUTONE VS63 GE EQUIVALENT LEVITON EQUIVALENT
<p>NOTES:</p> <ol style="list-style-type: none"> 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. FOR DRYERS AND RANGES, PROVIDE 3-POLE GROUNDING TYPE AS REQUIRED BY DEVICE. LOCATE DEVICE SO THAT DRYER OR RANGE CAN BE PUSHED TIGHTLY AGAINST WALL. 4. RECEPTACLES SHALL BE TAMPER RESISTANT AND WEATHER RESISTANT AND MARKED ACCORDINGLY AS REQUIRED BY N.E.C. 5. ALL RECEPTACLES INSTALLED IN DAMP OR WET LOCATIONS SHALL BE UL LISTED WEATHER RESISTANT TYPE. <p>! SEE ARTICLE 3, COLOR.</p>				

A. Small Motor Control Switches:

- (1) For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 or 277 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 devices are controlling or supplying emergency power from a standby source, the device color shall be red, as with switch toggles or receptacle fronts. Plate color shall match others on normal power in the building unless otherwise noted.

- C. 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. MANUAL DIMMERS

- A. Manual dimmers for incandescent, MR-lamp incandescent or fluorescent loads shall be matched to the type load intended to be controlled.
- B. Power rating shall be verified by examining the plans and suitable for the load, but in no case less than circuit load. Furnish dimmers in nominal power ranges of 600W, 1000W, 1500 watts, etc.
- C. Manual dimmers shall be provided with all solid state components, complete with choke coil and/or other R.F.I. suppression devices.
- D. Manual dimmers shall be suitable for mounting in single gang outlet box, ganging together in multi-section boxes where indicated, without derating being necessary.
- E. Manual dimmers shall be of the sliding-type, with detent stop at off position, full range control 0-100%. Lutron Company "Nova" Series or equivalent Lithonia, Lightolier.
- F. Manual dimmers for fluorescent lighting or low voltage transformer-fed incandescent fixtures shall be matched to suit the characteristics of the particular manufacturer's electronic ballast or transformer used in the dimming - type fixture. Submit shop drawings of dimmer in the same submittal as the lighting fixtures.

5. 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.
- F. Cover plates for computer, telephone or other system outlets shall be as required to meet supplier or the owner's requirements, as applicable. Color to match other plates on project. Furnish telephone plates with wall-mounting studs if mounted at 48" or higher. See devices schedule below.

6. COMMUNICATIONS DEVICES AND PLATES

- A. Communications devices and wall plates furnished for this project shall all be standard products, of the same manufacturer. They shall consist of a wall plate bezel, capable of holding snap-in devices as indicated.

- B. Color of communications wall plates shall match the color of all other plates furnished on the project, matching switch, receptacles, etc. unless specified otherwise below. Verify all color selections with the Architect.
- C. The color of communications wall plate snap-in inserts shall be as noted herein, or shall be per the owner's standards, if applicable. Verify color requirements prior to ordering any materials.
- D. Provide securely-fastened permanent labels in the faceplate of communications wall plates that clearly and legibly indicate the address or unique identifier for an individual jack.
- E. All communications wall plates shall be provided with a bezel capable of holding a minimum of four separate device inserts, unless otherwise noted. Provide blank inserts to close any unused positions, of a color to match the plate.
- F. Communications wall plates and devices shall be as manufactured by Panduit, Lucent Technologies, Leviton, AMP or approved equivalent.

DEVICE INSERT SCHEDULE	
Multimode Fiber Optic (Always Install in Pairs)	FDDI - Compatible 62.5/125µ, ST-Style Grey Color, Female (2 fibers terminated)
Ethernet Network Data	Category 6, 8 Pos/4 Pair Cable Color: Blue Jack Color: Orange RJ-45, EIA/TIA 568-B (4 pairs terminated)
Voice Circuits 4 Pair	Category 6, 8 Pos/4 Pair Cable color: Gray Jack Color: Ivory RJ-45, EIA/TIA 568-B (4 pairs terminated)
Fiber Optic 2 Strands	"SC"-Style Connectors Mounted in Adjacent Pairs - Black Color
Video Circuits	"F" Connector Bulkhead Style White Color (RG-6 coax termination)
Blank Cover	Color to Match Wall plate
Wall Plate (4-Port/1 Gang)	Color to Match Wiring Devices Used in Adjacent Areas
Special Comm. Port for T-1 and Special Communication Circuits	Orange Color RJ-31X, 8 Pos/4 Pairs Terminated

7. STANDARD SINGLE-SERVICE FLOOR BOXES

- A. In general, floor boxes to be used flush in concrete floors shall be of single-gang stamped steel construction, round, deep style, fully adjustable Hubbell B-2537 Series, Type 1 or equivalent.
 - B. Where multiple gangs are indicated on the plans (or elsewhere), multi-gang (up to 3 yokes maximum) stamped steel, rectangular, deep style units shall be used. They shall be fully adjustable, Hubbell B-2432 Series, Type 1, or equivalent. Multiple-gang boxes shall be provided with removable partitions between each section in accord with N.E.C., where power and non-power circuits enter the same box.
 - C. In general, all cover plates for floor boxes shall be flush, solid brass. Provide typical plates as listed:
 - Duplex Outlet - Round, Duplex Flap - Hubbell S-3925
 - Rectangular, Duplex Flap - Hubbell S-3825
 - Telephone or Data - Round, Combination 1" or 2 1/8" - Hubbell S-2725
 - Rectangular, Combination 1" or 2 1/8" - Hubbell S-2625
 - D. Furnish floor boxes with threaded hubs as required to suit conduit routings, 3/4" minimum.
 - E. Furnish carpet flanges for all boxes installed in carpeted areas. Flanges to be clear polycarbonate plastic, round - Hubbell S-3079 or rectangular, for gangs indicated - Hubbell S-308 Series or equivalent.
 - F. Floor outlet boxes shall be installed dead level flush with wood, VCT, concrete or other hard surface type floor. Furnish special stop trims for terrazzo where required.
 - G. Outlets within floor boxes shall be as specified elsewhere in these specifications.
8. SPECIAL MULTI-SERVICE FLOOR BOXES
- A. In general, floor boxes that are to contain multiple services such as power, data, voice, video, etc., shall be constructed of stamped steel and heavy thermoplastic with barriers or compartments to separate power from signal services per National Electrical Code.
 - B. Provide multi-service floor boxes with proper trim for carpet, wood, terrazzo, tile or concrete floors, wiring slots, dust covers and proper device plates to hold outlets, jacks, etc. They shall be fully adjustable. Conduit rough-in shall be as required. All tops shall be capable of receiving an insert of the surrounding floor material.
 - C. Outlets for multi-service floor boxes shall be as specified elsewhere in these specifications.
 - D. Set boxes dead level with flooring and provide proper support by thickening concrete slab, welding angle iron across joists below or other approved means.
 - E. Multi-service floor boxes shall be capable of containing a minimum of two duplex receptacles and two 4-position single gang modular plates for voice, video or data jacks and shall be as manufactured by Hubbell #HBLCFB401 base with #HBLTCGNT cover, with all required accessories or equivalent Walker "RFS" Series or Lew. If not installed on carpeted floors, provide flush brass trim.
9. 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 - STANDBY GENERATOR

1. 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.
- 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	300 KW
Standby KVA	375 KVA
Engine Rating Conditions	29.38 HG and 85°F
Power Factor at Specified KW	0.8%
Frequency	60 HZ
Maximum Ambient Temperature Rating	122°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 24" 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 122°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 693 (nominal) gallon tank or sized as needed for a minimum of 30 hours of run time, mounted beneath generator. 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.
- 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. Engine outlet and muffler outlet and all exhaust lines, with rain cap shall be sized to suit the engine back pressure as recommended by the engine manufacturer. Consider total system back pressure, including piping, muffler, pipe bends, etc., in sizing, routing and materials selections. All engine exhaust piping shall be pitched for drainage to prevent collection of moisture in piping. Provide materials, locate and mount silencer and piping to accommodate the anticipated high temperatures of the exhaust system, to protect structures, finishes and building occupants from contact with high temperature surfaces. All exhaust piping shall be completely gas tight, installed by qualified, skilled tradesmen in a manner as approved by the local authority having jurisdiction.

9. STARTING SYSTEM

- A. A 12 or 24 volt DC electric starting system with positive engagement drive shall be furnished.
- B. 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 1 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. A generator mounted main line molded case circuit breaker of XXX 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. MANUAL TRANSFER SWITCH

- A. Transfer switch 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. 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 be operated manually by maintenance staff.
- E. As a precondition for approval, all switches, complete with timers, relays and accessories shall be listed by UL under Standard UL 1008 Transfer Switches and shall be approved for use on power systems per NFPA and all applicable codes.
- F. Transfer switch ratings and accessories shall be as follows:
 - 1000 amp
 - 208 volts
 - 3 phase
 - 4 wire
 - 60 Hz
 - 3 pole
 - Wall mounted
 - Totally enclosed, NEMA 1
 - Solid neutral, insulated from enclosure
 - Ground bar, bonded to enclosure
- G. Transfer Switch Accessories:
 - (1) 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.
 - (2) Test switch to be mounted on cabinet - to provide for load, no-load and off-line, operation of emergency plant and transfer switch.
 - (3) Pilot lights for indicating switch in emergency (red) and normal (green) position.
 - (4) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on normal).
 - (5) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on emergency).
 - (6) Frequency relay - To prevent transfer to emergency until voltage and frequency of generating plant have reached 90 percent of rating.

- (7) 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, 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")
 (2) Distribution applications: 120 kA per phase (Category "B")
 (3) Non-receptacle applications: 40 kA per phase (Category "A")
 (4) Receptacle applications: 12 kA per phase (Category "A")

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

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(With internal disconnect switch 400V and 800V respectively).

- C. UL 1149 Listed Suppression Voltage Ratings for distribution shall not exceed the following: (Category "A" & "B")

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(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:
40 to 60 Ampere, 3 Pole, 600V, S/N, NEMA 1 disconnect, built into the unit and furnished by the supplier as an integral part of the equipment. Disconnecting means shall be capable of withstanding the available fault currents. Verify fault current with the Contractor.
 - Category "B" Devices, at Panels:
30 Ampere, 3 Pole Circuit Breaker in Protected Panel
 - Category "A" Devices, at Panels:
30 Ampere, 3 Pole Circuit Breaker in Protected Panel
- (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 as indicated on the contract documents. 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. PANELBOARD SURGE SUPPRESSION - CATEGORY "B" UNITS

- (1) Units shall be installed as indicated on the contract documents, set beside or above the distribution panel indicated, and connected as recommended by the equipment manufacturer.
- (2) Category "B" units shall be rated for 120/208 volts, 3-4 Wire Wye service. Units shall be minimum 120,000 ampere rated per phase, with less than 5 nanosecond reaction time. Provide fusing and fault indicator pilot lights as in (A) - General above.
- (3) Category "B" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.

D. BRANCH PANELBOARD SURGE SUPPRESSION - CATEGORY "A" UNITS (NON-RECEPTACLE APPLICATIONS)

- (1) Units shall be installed flush in finished areas. Units may be surface-mounted if in unfinished mechanical spaces and the panel protected is also surface-mounted. Locate as indicated on the contract documents and connect in exact accord with the manufacturer's recommendations. They shall be rated 40,000 amperes surge current, less than one nanosecond response time.
- (2) Category "A" units shall be rated for 120/208 volts, three phase, 4 wire wye service as indicated on the drawings. Units shall be fused in accord with (A) - General noted above.
- (3) Furnish unit with red and green indicator lights to signify normal operation and component or suppression capability failure.

E. 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 warranted 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.
- C. Category "B" and "A" devices to carry 5 year unconditional replacement warranty.

END OF SECTION 264313

SECTION 265113 - LIGHTING FIXTURES AND LAMPS

1. GENERAL

- A. Furnish and install all lighting fixtures, as herein specified, complete with lamps and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.
- 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 finger prints shall be restored to new condition or shall be replaced.
- C. Eight copies 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. (Verify shop drawing quantities with the Architect.)
- 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.
- G. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting Alzak cones and specular reflectors shall be handled with care during installation or lamping 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.
- H. Refer to architectural details as applicable for recessed soffit fluorescent 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.

2. VOLTAGE

- A. All lighting fixtures will be rated 120 volts, single phase as indicated or required.

3. BALLASTS

- A. Electronic Instant-Start Fluorescent Ballast Specifications

- (1) Fluorescent ballast to be instant-start high performance electronic to operate at a frequency of 20KHz or higher with less than 2% lamp flicker, at an input voltage of 108 to 132 VAC (120 volt line) at an input frequency of 60 Hz, minimum of .88 ballast factor, power factor no less than .98. Light output to remain constant for line voltage of $\pm 4\%$. Ballast to comply with EMI and RFI limits

set by FCC (CFR 47 part 18) for normal electrical equipment and have less than 1.4 lamp current crest factor (or less if required by the fluorescent lamp supplier). Verify this prior to submitting shop drawings. Ballast to meet ANSI Standard 82.41 and be UL listed Class P Type I. Ballast shall be non-PCB bearing.

- (2) Ballast to have less than 10% total harmonic distortion with less than 6% third harmonic distortion. Ballast to have "A" sound rating with a power factor no less than .98 and have a twenty year rated life. Ballasts used shall operate 1, 2, 3, or 4 T8 lamps as specified in the fixture specification. Use a 2, 3 or 4-lamp ballast to match number of lamps in fixture, and meet all switching requirements as shown on the drawings. Ballasts shall be unconditionally warranted by the manufacturer for a period of three years from the date of substantial completion.
- (3) GE, Sylvania, Osram or equal are acceptable manufacturers.
- (4) Provide in-line fuse-holder(s), with fuse sized per manufacturer's recommendations for each 120 volt fixture.

NOTE: No single 2, 3, or 4 lamp ballast with 2 source input will be allowed for any fixture(s) shown supplied by both normal and emergency power.

- B. Metallic vapor lamp (H.I.D.) ballast shall be rated 120 or 277 or 480 volts, 60 Hertz energy-saving high power factor, copper wound, auto regulator type for single lamp, complete with external fuse holder (Bussmann HLR) and as manufactured by Jefferson, G.E., or Advance. All vapor lamp ballasts shall be encapsulated or potted to minimize the amount of audible hum produced. No open core and coil ballasts shall be provided unless specifically indicated in the fixture description. Ballast factor for all H.I.D. ballasts shall be $1.0 \pm 5\%$ tolerance. Ballast shall deliver full wattage, to match the rating of the lamp, assuming proper input voltage, within the tolerance range noted.
- C. Where lighting standards have fuses protecting ballasts, an in-line type of fuseholder shall be located at the base of the pole, readily accessible behind the handhole coverplate. Where multiple circuited luminaires are on a single pole, identify the separate fuseholders.

4. 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:
 - (1) 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.
 - (2) Color shift over 6,000 hours shall be <0.007 change in $u' v'$ as demonstrated in IES LM80 report.
 - (3) The color rendition index (CRI) shall be 80 or greater

- (4) LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

5. 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 – 277 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
- F. Dimming shall be controlled by a 0-10V signal, or if require “DMX”.
- 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.
- L. The electronics/power supply enclosure shall be internal to the SSL luminaire and be accessible per UL requirements.
- M. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

6. ELECTRICAL

- a. Power Consumption: Maximum power consumption, +/- 5% when operating between 120 – 277V (or 346V) shall be as follows:
- b. A minimum of 110 lumens per watt.
- c. Operation Voltage - The luminaire shall operate from at 60 HZ \pm 3 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage of plus or minus 10% shall have no visible effect on the luminous output.
- d. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

- e. 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.
 - f. 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.
 - g. In Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps² – seconds.
 - h. 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.
 - i. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - j. Adjustment of forward LED voltage, supporting 3V through 60V.
 - k. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 - l. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
 - m. Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.
 - n. All electrical components shall be RoHS compliant.
7. LED PHOTOMETRIC REQUIREMENTS
- a. Luminaire performance shall be tested as described herein.
 - b. Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.
 - c. Luminaire lighting performance shall be adjusted (depreciated) for the minimum life expectancy

- d. The performance shall be adjusted (depreciated) by using the LED manufacturer's data or the data from the IESNA Standard TM-21 test report, whichever ever one results in a higher level of lumen depreciation.
- e. The ratio of the peak-to-zenith maximum candela ratios shall be – 1.94:1 @ 127.5 degrees.
- f. The luminaire may be determined to be compliant photometrically, if:
- g. The initial minimum illuminance level is achieved in 100% of the area of the specified lighting pattern
- h. The measurements shall be calibrated to standard photopic calibrations.

8. LED THERMAL MANAGEMENT

- a) The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
- b) The LED manufacturer's maximum junction temperature for the expected life.
- c) The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
- d) The luminaire shall have an UL rating.
- e) The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

9. LED OPTICS

- a) Optics shall consist of a high performance lens, diffusers and metal reflector.
- b) Optics shall eliminate source image.

10. LAMPS

- A. Lamps furnished and installed in indicated fixtures shall be as manufactured by G.E., Westinghouse, Phillips, Osram or Venture. Wherever possible, all lamps provided shall be manufactured in the United States of America.
- B. All incandescent lamps shall be rated 130 volts with a medium screw type base (or as required) in wattages less than 300 watts and 130 volts, mogul screw type base in 300 watts and larger.
- C. T-8 rapid start low mercury lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 4100k, and an average rated life of 20,000 hours. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL1. Osram, Westinghouse, Philips, and General Electric are acceptable manufacturers.

11. LIGHT FIXTURE GENERAL REQUIREMENTS

A. Fluorescent Recessed Lighting Fixtures - General Requirements

- (1) The following are minimum requirements for recessed fluorescent fixtures for lay-in grid, gypsum board, plaster and concealed spline ceilings. Surface-mounted fluorescent 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. Troffers shall be equivalent to Hubbell "Versaline," Daybrite "Designer," Lightolier equivalent or Lithonia "2SPG" series.
- (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 ballast cover, wiring channel, or socket track. Exposed wiring is not acceptable. Connection wiring shall be accessible thru a hinged access plate above ballast channel in top of unit.
- (4) Ballasts shall be as specified. If a manufacturer and series number is listed, substitution by other manufacturers shall be of the exact same specification (sound rating, energy consumption, life expectancy, warranties, physical size, heat and temperature ratings), etc. All ballasts shall be instant-start, cool operating, of the electronic energy-saving type, UL and CBM listed.
- (5) The complete light fixture unit shall be UL listed and labeled. Other agency listings may be acceptable with written approval from the Engineer.
- (6) Fixture lens doors shall be reversible, hinged, painted after fabrication, with spring-loaded or other mechanically stable positive action latches.
- (7) 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".
- (8) 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.
- (9) 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.
- (10) 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.
- (11) Each type of fluorescent (or other type) 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.

- (12) Lamps shall be as specified in lamp section of these specifications, and suitable for use in the fixture intended. If the lighting fixture manufacturer requires a specific lamp for optimum performance, that lamp shall be furnished.
- (13) Do not provide pressure-lock or any other type of lampholder unless specifically indicated to the contrary or required by local codes. Fixtures may be shipped from the factory with lamps installed, at the Contractor's option.

B. Industrial and Striplight Fluorescent 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 ballast covers, heavy-duty lampholders and wire guards where specified. Wire guards shall be heavy-duty #14 wire gauge) minimum with corrosion-resistant plated or vinyl finish.
- (5) Ballasts to be as specified herein.
- (6) Units to be UL listed.
- (7) 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. Exit Lights - General Requirements

- (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. 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. 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) Lamps shall be long-life type, as specified.
- (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.

D. Exterior Wall Pack - General Requirements

- (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Mountings shall be wall, universal type, to suit the installation conditions.
- (2) Complete unit to be finished in color as selected by the Architect.
- (3) Lamps shall be LED. Normal color to be 4000° Kelvin unless specified otherwise in fixture list. Normal power input to be 66 watts.
- (4) Distribution shall be type II medium.

E. Exterior Wall Grazer - General Requirements

- (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Mountings shall be wall, universal type, to suit the installation conditions.
- (2) Complete unit to be finished in color as selected by the Architect.
- (3) Lamps shall be LED.

F. Exterior Parking lot fixtures - General Requirements

- (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Mountings shall be pole, universal type, to suit the installation conditions.
- (2) Complete unit to be finished in color as selected by the Architect.
- (3) Lamps shall be LED. Normal color to be 4000° Kelvin unless specified otherwise in fixture list.

12. PHOTOCELLS

- A. Provide 120 volt, 1000 or 2000 watt photocells as needed for control of certain circuits or fixtures as indicated on plans. They shall be as manufactured by Tork, Paragon, AMF or approved equivalent.
- B. Mount photocells in locations concealed from sight lines standing on ground unless otherwise noted, in which case the final position shall be as directed by the Architect. Group together (if indicated at one location) and mount on back of parapet wall or otherwise properly support with mounting bracket. Coordinate with roofing installer to ensure that roof penetrations are properly made without violating or reducing the roof warranty in any way. Photocells may be mounted in other locations if it is not practical to install them on roofs or parapets, in which case the Contractor shall request direction for their mounting locations from the Engineer or Architect. Photocells shall always be mounted in a weatherproof, inconspicuous manner.

13. TIMECLOCKS

- A. Provide synchronous motor-driven timeclock(s) to control the indicated loads. The number of poles, their ampacity and voltage withstand shall be to suit the load, but in no case less than 30 amps.
- B. Timeclock coil and motor power shall be 120 volts AC, backed up with seven day spring winder which is automatically replenished in normal operation. Provide a 120 volt control circuit from the nearest available panelboard.

- C. Provide with an astronomical dial, set up and calibrated for the week and month the timeclock is placed in operation. Order unit for the proper geographical latitude for the project site. Also provide day light savings time option and calibrate for April-October dates. Provide instruction to the Owner's representative in proper setting and operation of each type of timeclock provided.
- D. Enclosures for timeclocks shall be surface type, NEMA 1.

END OF SECTION 265113

SECTION 270610 – VOICE/DATA/VIDEO COMMUNICATIONS SYSTEM

1. GENERAL

a. RELATED DOCUMENTS

- 1) 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.
- 2) All layout and installation of communications infrastructure shall be in accordance with ANSI / TIA 568 and the BICSI TDMM.

b. SUMMARY

- 1) Section Includes:
 - (a) Pathways.
 - (b) UTP cabling.
 - (c) Optical Fiber cabling.
 - (d) Cable connecting hardware, patch panels, and cross-connects.
 - (e) Telecommunications outlet/connectors.
 - (f) Cabling system identification products.
 - (g) Cable management system.
- 2) The Contractor shall furnish all materials, labor, services, purchasing, testing of completely installed systems, etc., that are indicated or required to provide a complete telecommunications distribution network for the project.
- 3) The telecommunications distribution network shall be designed and installed in a format and construction as required for an IEEE 802.3ae compliant 1Gb Ethernet system. It shall be physically wired in a star configuration.
- 4) The telecommunications distribution system shall be installed complete, except as hereinafter described. The system shall be provided with all wall plates, inserts, wiring, equipment racks and supports, copper and fiber termination equipment, connections, wire terminations and identifications, 120 VAC power outlets, grounding etc., for a completely functioning premises wiring network. Components of each subsystem shall be of one manufacture, and be tested and certified as compatible to provide the specified performance.
- 5) The system active electronic hardware and software shall be installed by the Owner or his vendor, unless otherwise noted or specified.

c. BACKBONE CABLING DESCRIPTION

- 1) Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects,

mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

- 2) Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- 3) Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-C.1, when tested according to test procedures of this standard.

d. HORIZONTAL CABLING DESCRIPTION

- 1) Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols. Splices shall not be installed in the horizontal cabling.
- 2) The maximum allowable horizontal cable length is 275 feet.
- 3) Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-C.1, when tested according to test procedures of this standard.

e. SUBMITTALS

- 1) Product Data: For each type of product indicated.
 - (a) Submittals shall also be accompanied by a detailed bill of material, including part numbers and quantities.
- 2) Shop Drawings:
 - (a) System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - (b) Cabling administration drawings and printouts.
 - (c) Wiring diagrams to show typical wiring schematics including the following:
 - i) Cross-connects.
 - ii) Patch panels.
 - iii) Patch cords.
 - (d) Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 - (e) Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - i) Vertical and horizontal offsets and transitions.
 - ii) Clearances for access above and to side of cable trays.
 - iii) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - iv) Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- 3) Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

- 4) Source quality-control reports.
- 5) Field quality-control reports.
- 6) Maintenance Data: For connectors to include in maintenance manuals.

f. QUALITY ASSURANCE

- 1) Installer Qualifications: Cabling Installer must have personnel certified by the cable manufacturer or BICSI on staff.
- 2) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3) Telecommunications Pathways and Spaces: Comply with NFPA 70, and TIA/EIA-569-A.

g. Grounding: Comply with NFPA 70, and ANSI/TIA-607-B

h. DELIVERY, STORAGE, AND HANDLING

- 1) Test cables upon receipt at Project site.
 - (a) Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 - (b) Test each pair of UTP cable for open and short circuits.

i. COORDINATION

- 1) Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.
 - (a) Meet jointly with telecommunications and LAN equipment suppliers, Engineer, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - (b) Record agreements reached in meetings and distribute them to other participants.
 - (c) Adjust arrangements and locations of racks, sleeves, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone and LAN equipment.
- 2) Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

2. PRODUCTS

a. PATHWAYS

- 1) General Requirements: Comply with ANSI/TIA-569-C.
- 2) Cable Trays:

- (a) Comply with requirements in Division 26 Section "Raceways & Fittings".
- 3) Conduit and Boxes: Comply with requirements in Division 26 Sections "Raceways and Fittings" and "Cabinets, Outlet Boxes, and Pull Boxes".
 - (a) Outlet boxes shall be no smaller than 4" x 4" x 2 5/8" with a double gang plaster ring and integral wire management.
 - (b) Minimum conduit size is 1". Interior conduit shall be EMT or RGS. Exterior conduit shall be Schedule 40 PVC.
 - (c) All conduits shall be stubbed out from wall to an accessible point above ceiling or to the bottom of structure when no ceiling is to be installed. Provide category-rated J-hook path to cable tray.
 - (d) Provide all conduits with connector and plastic bushing at termination point.
- b. BACKBOARDS
 - 1) General Frame Requirements:
 - (a) Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - (b) Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
 - (c) Finish: Manufacturer's standard, baked-polyester powder coat.
 - 2) Floor-Mounted Racks: Modular-type, steel construction.
 - (a) Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
 - (b) Baked-polyester powder coat finish.
 - (c) Two-post racks shall be furnished with a 16 1/4" wide upright for extended equipment support.
 - 3) Cable Management for Equipment Frames:
 - (a) Metal, with integral wire retaining fingers.
 - (b) Baked-polyester powder coat finish.
 - (c) Vertical cable management panels shall have front and rear channels, with covers. Provide vertical management on both sides of all racks.
 - (d) Provide horizontal crossover cable manager at the top of each relay rack and between/below all patch panels, with a minimum height of two rack units each.
- c. UTP BACKBONE CABLE
 - 1) Description: 100-ohm, UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket.
 - (a) Comply with ANSI/ICEA S-90-661 for mechanical properties.
 - (b) Comply with TIA/-568-C.1 for performance specifications.
 - (c) Comply with TIA/-568-C.2, Category 6.
 - (d) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

- i) Communications, Riser Rated: Type CMR or CMP complying with UL 1666.
 - 2) All cable that enters or exits any building shall be provided with MOV protectors on each end.
- d. UTP BACKBONE CABLE HARDWARE
 - 1) General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 - 2) Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
 - 3) Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 4) Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - (a) Number of Jacks per Field: One for each four-pair UTP cable indicated plus spares and blank positions adequate to suit specified expansion criteria.
 - 5) Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- e. UTP HORIZONTAL CABLE
 - 1) Description: 100-ohm, 4-pair Unshielded UTP, covered with a thermoplastic jacket.
 - (a) Comply with ICEA S-90-661 for mechanical properties.
 - (b) Comply with ANSI/TIA-568-C.1 for performance specifications.
 - (c) Comply with ANSI/TIA-568-C.2 Category 6 up to 250 MHz.
 - (d) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - i) Communications, General Purpose: Type CM or CMG.
 - ii) Communications, Riser Rated: Type CMR or CMP.
- f. UTP CABLE HARDWARE
 - 1) General Requirements for Cable Connecting Hardware: Comply with ANSI/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 - 2) Connecting Blocks: Shielded modular jack to be compatible with cabling system. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
 - 3) Patch Panel: Modular panels housing 24 or 48 modular snap-in jack units.

- (a) Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- 4) Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- 5) Patch Cords: Provide factory-made, four-pair Category 6 cables in 48-inch lengths; terminated with eight-position modular plug at each end.
 - (a) Patch cords shall have bend-relief-compliant. Patch cords shall have latch guards to protect against snagging.
 - (b) Provide quantity to match quantity of horizontal cables.

g. TELECOMMUNICATIONS OUTLET/CONNECTORS

- 1) Jacks: 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.2 up to 250 MHz.
- 2) Workstation Outlets: Connector assemblies mounted in two gang faceplate. Provide number of ports as shown on the Drawings.
 - (a) Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices and Plates."
 - (b) For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - i) Flush mounting jacks, positioning the cord at a 45-degree angle.
 - (c) Legend: Snap-in, clear-label covers and machine-printed paper inserts.

h. OPTICAL FIBER CABLE

- 1) Description: Multimode, 50/125 micrometer, laser optimized, non-conductive, loose tube backbone optical fiber cable. Singlemode, 8.3/125 micron, laser optimized, non-conductive, loose tube backbone optical fiber cable.
 - (a) Comply with ICEA S-83-596 for mechanical properties.
 - (b) Comply with TIA/EIA-568-C.3 for performance specifications.
 - (c) Comply with ANSI/TIA-492AAAA-B for detailed specifications.
 - (d) Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70.
 - (e) Provide with central non-conductive strength member.
 - (f) Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm.
 - (g) Individual fiber strands shall be color coded per telecommunications industry practice.
 - (h) Number of strands shall be as noted on Drawings
 - (i) Fiber strands shall meet the following specifications:
 - i) Fiber Type - glass core, glass cladding.
 - ii) Core Diameter Multimode - 50 microns +/- 3 microns
 - iii) Core Diameter Singlemode- 8.3 microns +/- 3 microns
 - iv) Core/Clad Concentricity Error- < or = 3.0 microns.
 - v) Cladding diameter - 125 microns +/- 1 micron.
 - vi) Cladding Noncircularity- < or = 1%.
 - vii) Maximum Multimode attenuation at 850 nanometers (nominal) 3.0 dB/km.
 - viii) Maximum Multimode attenuation at 1300 nanometers (nominal) 1.0 dB/km.

- ix) Maximum Singlemode attenuation at 850 nanometers (nominal) 1.0 dB/km.
- x) Maximum Singlemode attenuation at 1300 nanometers (nominal) 1.0 dB/km.
- xi) ISO/IEC 11801 Type: OM3 for multimode. OS2 for singlemode.

2) Jacket:

- (a) Jacket Color: Aqua.
- (b) Cable cordage jacket, fiber, unit, and group color shall be according to ANSI/TIA-598-C.
- (c) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- (d) Hybrid single mode/multimode cable may be used subject to performance criteria above.

i. OPTICAL FIBER CABLE HARDWARE

- 1) Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - (a) Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- 2) Patch Cords: Provide factory-made, dual-fiber cables in 36-inch (900-mm) lengths, quantity to match quantity of fibers.
- 3) Cable Connecting Hardware:
 - (a) Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with ANSI/TIA-568-C.3.
 - (b) Quick-connect, simplex and duplex, Type SC.

j. SOURCE QUALITY CONTROL

- 1) Factory test UTP and optical fiber cables on reels according to ANSI/TIA-568-C.1.
- 2) Factory test UTP cables according to ANSI/TIA-568-C.2.
- 3) Cable will be replaced by contractor if it does not pass tests listed above and inspections.
- 4) Prepare test and inspection reports.

k. GROUNDING

- 1) Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.
- 2) Telecommunications Main Bus Bar:
 - (a) Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 - (b) Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
 - (c) Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

- 3) Comply with ANSI -607-B.

I. LABELING

- 1) Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

3. EXECUTION

a. ENTRANCE FACILITIES

- 1) Install buried entrance pathway complying with Division 26 Section "Raceway and Fittings".
- 2) Comply with NECA 1.
- 3) Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- 4) Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

b. WIRING METHODS

- 1) Wiring Method: Install cables completely within raceways and cable trays. Conceal raceway except in unfinished spaces.
 - (a) Comply with requirements for raceways and boxes specified in Division 26 Sections "Raceway and Fittings" and "Cabinets, Outlet Boxes, and Pull Boxes".
- 2) Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

c. INSTALLATION OF PATHWAYS

- 1) Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-C.
- 2) Comply with ANSI/TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.
- 3) Install manufactured conduit sweeps and long-radius elbows whenever possible.
- 4) Pathway Installation in Communications Equipment Rooms:
 - (a) Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - (b) Install cable trays complete around room as shown on drawings. Install cable ladder directly on top of racks and connect to perimeter tray.
 - (c) Secure conduits to backboard when entering room from overhead.
 - (d) Extend conduits 4 inches above finished floor and/or 18" below ceiling structure.

- (e) Install metal conduits with grounding bushings and connect with grounding conductor to grounding bar.
- 5) Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints. Provide on all walls.
- d. INSTALLATION OF CABLES
- 1) Comply with NECA 1.
 - 2) General Requirements for Cabling:
 - (a) Comply with ANSI/TIA-568-C.1.
 - (b) Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - (c) Install 110-style IDC termination hardware for backbone cable and modular jacks for horizontal cable.
 - (d) Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - (e) Cables may not be spliced.
 - (f) Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - (g) Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - (h) Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - (i) Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 - (j) In the communications equipment room, install a 30-foot long service loop on each end of fiber optic cable. Copper cables shall take the longest path around the room prior to landing on racks.
 - (k) Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 3) UTP Cable Installation:
 - (a) Comply with ANSI/TIA-568-C.2.
 - (b) Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 4) Optical Fiber Cable Installation:
 - (a) Comply with ANSI/TIA-568-C.3.
 - (b) Cable shall be terminated on connecting hardware that is rack mounted.
 - (c) All optical fiber cable installed shall be provided with supplemental protection. (1" minimum innerduct.)
 - 5) Group connecting hardware for cables into separate logical fields.
 - 6) Separation from EMI Sources:
 - (a) Comply with BICSI TDMM and ANSI/TIA-598-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

- (b) Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - i) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - ii) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - iii) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - (c) Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - i) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - ii) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - iii) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - (d) Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - i) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - ii) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - iii) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - (e) Separation between Communications Cables and Electrical Motors and Transformers, HP and Larger: A minimum of 48 inches.
 - (f) Separation between Communications Cables and Fluorescent Fixtures: A minimum of 12 inches.
- 7) A pull string shall be installed in all conduits, including those with cables installed. String shall be securely tied off at both ends.
- e. FIRESTOPPING
- 1) Comply with requirements in Division 07 Section "Penetration Firestopping."
 - 2) Comply with ANSI/TIA-569-C, Annex A, "Firestopping."
 - 3) Comply with BICSI TDMM, "Firestopping Systems" Article.
- f. GROUNDING
- 1) Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
 - 2) Comply with ANSI-607-B.
 - 3) Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
 - 4) Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

- (a) Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.
- g. IDENTIFICATION
- 1) Identify system components, wiring, and cabling complying with ANSI/TIA-606-B. The identification scheme shall be coordinated with the owner prior to any labeling or testing.
 - 2) Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
 - 3) Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 - 4) Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.
 - 5) Cable and Wire Identification:
 - (a) Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - (b) Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - i) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - ii) Label each unit and field within distribution racks and frames.
 - (c) Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - (d) Both ends of all backbone cable shall be labeled. Labels will be self laminating and machine generated. The label shall contain the following information:
 - i) The Origination (TR it is feeding from).
 - ii) The Destination (TR it is feeding).
 - iii) Number of pairs or fibers
 - (e) Both ends of all horizontal cables shall be labeled. Labels shall be self-laminating and machine generated. The cable, workstation faceplate, panel ports and block positions shall be labeled with the room number, location in room, outlet type & # (data D1, D2, etc). In rooms with multiple outlets, label clockwise as you enter the room: 1, 2, 3 e.g. a data port at the first drop location to the left of Room 216 door would be (216-1 D1). When terminating workstation cables in the TR, organize and label the cables in numeric room number order at the patch panel.

- (f) CNS will approve all labeling schematics prior to installation. "As-Built" drawing with all outlets identified shall be provided.
- 6) Labels shall be self-laminating or computer-printed type with printing area and font color that contrasts with cable jacket color. Handwritten labels will not be acceptable.
- (a) Cables use flexible vinyl or polyester that flex as cables are bent.
- h. FIELD QUALITY CONTROL
- 1) Perform tests and inspections.
 - 2) Tests and Inspections:
 - (a) Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-C.1.
 - (b) Visually confirm Category marking of outlets, cover plates, outlet/connectors, and patch panels.
 - (c) Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - (d) Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - i) Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - (e) Optical Fiber Cable Tests:
 - i) Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - ii) Link End-to-End Attenuation Tests:
 - a) All multimode fiber cables shall be tested at both 850 nm and 1300 nm after installation. Printed test results for each fiber strand are required. All tests are to be performed in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper. Fibers will be considered acceptable if the OTDR trace for that fiber shows an end to end loss of less than $xx\text{dB} + yy(0.2)\text{dB} + zz(0.5)\text{dB}$ (where yy is the number of splices, zz is the number of connector pairs and xx is calculated using the following formula: $xx = \text{distance} \times \text{fiber attenuation/unit distance} @ \text{lambda}$). In addition, no splice may show a loss of greater than 0.2 dB and no connector pairs may show a loss of greater than 0.5 dB. Any additional tests required by the ANSI/TIA/EIA standard shall also be performed and also included in the written test report.
 - b) The vendor shall perform tier 2 testing on each fiber strand utilizing a OTDR bi-directional tester at the wavelengths specified above. Overall, the OTDR test results shall be made up of the wavelength of the conducted test, the link length, attenuation, cable identification, the locations of the near end, the far end and each splice point or points of discontinuity. Hard-copy and electronic

copy results for each fiber strand shall be submitted as part of "As- Built" documentation.

- (f) UTP Performance Tests:
 - i) Test for each outlet. Perform the following tests according to ANSI/TIA-568-C.1 and ANSI/TIA-568-C.2:
 - a) Wire map.
 - b) Length (physical vs. electrical, and length requirements).
 - c) Insertion loss.
 - d) Near-end crosstalk (NEXT) loss.
 - e) Power sum near-end crosstalk (PSNEXT) loss.
 - f) Equal-level far-end crosstalk (ELFEXT).
 - g) Power sum equal-level far-end crosstalk (PSELFEXT).
 - h) Return loss.
 - i) Propagation delay.
 - j) Delay skew.
- (g) Final Verification Tests: Perform verification tests for UTP, and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
 - i) Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- 3) Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- 4) If the cable or termination fails to meet the above requirements, it shall be replaced by the contractor at the contractor's expense.
- 5) Prepare test and inspection reports documenting compliance with all requirements of these specifications. Provide three (3) printed copies and two (2) compact disks of all data.
- i. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and covering follow-on support after project completion.
- j. WARRANTIES
 - 1) INSTALLATION WARRANTY. The Contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.
 - 2) Copper drops shall be warranted to results defined in the channel specifications of ANSI/TIA-568-C.2 Category 6 up to 250MHz.

- 3) Fiber optic links shall be warranted to the link and segment performance minimum expected results defined in ANSI/TIA-568-C.1.

END OF SECTION 270610

SECTION 270640 - CATV DISTRIBUTION SYSTEM

1. SCOPE OF WORK

- A. Furnishing of all labor, project management, materials, tools, equipment necessary for the complete installation of a CATV Distribution System as shown on the plans and as herein specified.
- B. The Electrical Contractor shall provide conduit systems from box to cable tray and mount all boxes for the Systems wiring. The Systems supplier shall provide special boxes for installation by the Electrical Contractor.
- C. It is the intent of these specifications and the accompanying plans that the Contractor furnishes and installs a system complete in every respect and ready to operate. All miscellaneous items and accessories required for such installation, whether or not each such item or accessory as shown on the plans or mentioned in these specifications, shall be furnished and installed.
- D. It shall be the responsibility of each bidder to examine the site, plans and specifications carefully before submitting his bid, with particular attention to errors, omissions and conflicts between city ordinances, plans and specifications. Any such discrepancy discovered shall be brought to the attention of the Engineer and will be included in the Base Bid.
- E. 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.

F. SUBMITTALS

- (1) Provide complete brochure information on all components and accessory equipment with the bid documents. All information shall be clearly marked to indicate items provided.
- (2) Contractors wishing to propose systems which differ in any features, functions or operating characteristics other than those outlined in these specifications must do so in writing to the specifying authority at least ten (10) days prior to bid opening. Proposals must include detailed information showing all deviations from the system as specified. Final approval of the alternate system shall be based on the decision of the Owner.

G. REGULATORY LISTING

(1) UL LISTING

All Material and equipment shall be listed, labeled, or certified by Underwriters Laboratories, Inc. The Intercom/paging system shall be UL813 listed as a complete system. All power supplied and computers shall be UL listed. Provide UL listing cards for all components specified herein.

H. MANUFACTURER

The equipment specified herein is that of Blonder Tongue, Peerless, Zenith and Precision Industries Incorporated. These manufacturers constitute the quality of design and construction, operational

characteristics, appearance standards, space requirements and field service staffing levels required to comply with the requirements of the specification.

2. PRODUCTS, PERFORMANCE CRITERIA

- A. The system shall comply with the radiation limitations as set forth under Part 15 as amended of the FCC Rules.
- B. All equipment shall be designed and rated for 110 volt, 60 cp's AC operation and shall be UL rated for 24-hour day continuous operation.
- C. The system shall have a signal to noise ratio of 43 dB or greater.
- D. The overall system frequency response shall be flat to +/- 1 1/2 dB across the 6-megacycle bandwidth of any television channel.
- E. The overall system shall have a voltage standing wave ratio of 1.2 to 1 or less.
- F. The design and installation of the system shall be such that extensions, additions, or modifications will be possible without altering the system requirement of a voltage standing wave ratio of 1.2 or less.
- G. The signal at any output shall not be less than 1000 microvolts or more than 10,000 microvolts into 75 ohms, except that in areas where direct pickup is possible, the signal shall not be less than 3000 microvolts. The signal at each outlet shall equal or exceed in quality the signal available from the Cable TV Company and shall be within 15 dB of same signal at any other outlet of the system.
- H. Extraneous signal pickup shall be at least 50 dB down from desired normal minimum signal level.
- I. Isolation between outputs and outlets shall not be less than 24 dB.
- J. Upon completion of the system installation it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.
- K. Each cable feeder line shall be inspected for proper termination.
- L. Signal-to-noise test shall employ a Jerrold Model 727 field strength or equivalent. Measurements shall be made at the output of the last amplifier in the system. With the normal levels in the system the field strength meter shall be tuned to the picture carrier of each channel in turn and the reading obtained on the meter noted. The signal shall then be removed and the input of the head end amplifier shall be terminated in 75 ohms. With the field strength meter read the level of remaining noise in the absence of the signal and add a meter correction factor of 4 dB to the reading. The difference between the two readings will give the system's signal-to-noise ratio, and shall not be less than 43 dB.
- M. No visible components of cross channel intermodulation ghosting or beat interference shall appear on the screen of a receiver turned to any normal signal.
- N. Should such a demonstration of performance show that the Contractor has not properly balanced the system and that picture degradation is present or that output gain is not as specified, the Contractor shall make all necessary changes or adjustments and a second performance demonstration will be arranged at no cost to the Owner.

3. EQUIPMENT

A. DISTRIBUTION AMPLIFIERS

- (1) The distribution amplifiers shall be a 19" rack mount, completely solid-state unit for the amplification of TV channels 2-61. Output level for each channel shall be +46dbmV minimum with no visible distortion.
- (2) Amplifier gain controls shall be provided with minimum of 15db control range. Typical amplifier gain shall be 51db.
- (3) The distribution system shall contain built-in regulated power supply to prevent change in output capability, and output level with changes in A-C line voltage of 117 VAC. Systems without regulated power supplies shall not be accepted.
- (4) Amplifier shall be a Blonder-Tongue, RMDA 450-50.

B. SPLITTERS

- (1) "2" way line splitters shall have a flat frequency response over the entire operating band from 500 to 600 MHz. The unit shall be of the hybrid design with a 75-ohm match of 17.0 dB RL minimum on all inputs and outputs. Output isolation shall be not less than 27.0 dB.
- (2) "4" way line splitters shall have a flat frequency response over the entire operating band from 500-600 MHz minimum on all input and outputs. Output isolation shall be not less than 27.0 dB.
- (3) Splitters shall be Blonder-Tongue Model CRS-2 and CRS-4.

C. CABLES

- (1) Each reel of coaxial cable used in the system shall be sweep tested for transmission and structural return loss and be so certified in writing by the cable manufacturer. Transmission sweep tests shall establish conformance to guaranteed loss value from 20-108 MHz 174-216 MHz and 470-890 MHz. Structural return loss tests by sweep method shall show a minimum return loss of 26 dB RL VHF, 16 dB RL UHF, as compared to a fixed 75-ohm reference from 20-108 MHz 174-216 MHz and from 470-890 MHz.
- (2) Coaxial cables shall be run in continuous lengths except for terminations and no splices shall be permitted in any conduit run. Cables shall be installed to avoid sharp bends or physical distortion.
- (3) All cables terminating at amplifiers or splitters shall be tagged as to function and destination.
- (4) The coax cable to rooms shall be plenum rated RG-6/U coaxial cable with the following properties:
 - a. Nominal impedance: 75 ohms
 - b. Minimum center conductor size: 22 AWG solid
 - c. DC resistance maximum: 50 ohms/M
 - d. Nominal capacitance: 19 pF/ft + or 1 15%
 - e. Shield coverage minimum: 95%
 - f. Minimum number of shields: 2
 - g. Dielectric jacket type: plenum rated
 - h. Nominal velocity of propagation: greater than 70%
 - i. 100% sweep tested 5 - 500 MHz
- (5) All trunk cable shall be plenum rated RG-11U type.

D. DIRECTION TAPOFFS

- (1) All 1,2, or 4 tapoffs shall have a frequency range of 5 to 600 MHz.
- (2) All tapoffs must meet all CATV and SMATV requirements for RF shielding.
- (3) A variety of isolation valves shall be available to balance all signal levels.
- (4) Tapoffs shall be equal to Blonder Tongue CRT series.

E. TV WALL PLATES

Provide a feed through F connector wall plate equal to Blonder Tongue V-1GF-FT at all TV locations.

F. AGILE CHANNEL PROCESSORS

Provide agile heterodyne processors to convert any cable channel in the 50 to 80t MHz frequency range to any channel in the 50 to 550 MHz frequency range. Each unit shall have synthesized frequency control, with a tuning increment of 250 kHz. Frequency selection is accomplished via front panel DIP switches. The unit shall have an output level of +40dBmV. Channel selection shall be as directed by the Owner. The unit shall be equal to a Blonder Tongue model AP-40-550. Provide 12 units for this project.

G. CHANNEL MODULATORS

The channel modulators shall be part of modular headend system. The rack chassis shall have positions for up to 12 modulator or demodulator modules. The chassis shall be equal to Blonder Tongue MIRC-12 chassis with MIPS-12 power supply. The channelized, heterodyne audio/video modulator shall be able to provide an audio and video modulated RF carrier output on any single VHF channel in the 54 to 400 MHz range. The output level shall be +38 dBmV. Channel selection shall be as directed by the Owner. The unit shall be equal to Blonder Tongue model MICM. Provide 12 modules for this project.

H. PASSIVE COMBINERS

Provide passive combiners to combine the outputs of multiple modulators and Processors. These units shall feature high isolation between ports and a low net combining loss from each of the broadband inputs the unit shall be equivalent to Blonder Tongue model OC-12D. Provide units as required to accommodate the total number of channels for this project.

I. EQUIPMENT HOUSING

Provide all cable TV headend equipment in paging/intercom rack. Provide two 120VAC, 20 Amp power circuits in equipment housing for headend equipment.

J. SURGE PROTECTION

Provide a Ditek DT6F or equivalent surge protector and 1 3/4" conduit with coax as noted on drawings from headend to KET satellite dish location.

4. EXECUTION

A. INSTALLATION

- (1) Install cable in conduit or cable tray, which is provided by the Electrical Contractor.
- (2) All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
- (3) Provide for adequate ventilation in all equipment racks and take precautions to prevent electromagnetic or electrostatic hum. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

B. WIRING

It shall be the responsibility of the Contractor to furnish and install all plenum rated cable as required to provide a complete and operable system. Cable shall be properly supported above ceilings.

C. TESTING

- (1) Upon completion of the installation, the system must be tested by the manufacturer's representative and all necessary modifications and/or adjustments must be made to assure compliance with this specification.
- (2) All final signal dB levels of TV outlets and amplifier inputs and outputs shall be shown on as built drawings.

D. CERTIFICATION

Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

E. INSTRUCTION

The work shall include supplying the services of a field service representative who shall be a full-time employee. The field service representative shall have specialized experience in the operation and maintenance of the system and shall instruct the Owner's personnel in the techniques involved in the operation of the systems. A formal on-site training shall be provided by the Contractor to the owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all components. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the Owner.

F. DIAGRAMS, DRAWINGS AND INSTRUCTION MANUALS

Furnish bound instruction manuals for the complete system for the Owner's use. Manuals shall include instructions, block and schematic diagrams, wiring diagrams, specification and technical data of the components and "as-built" drawings of the completed system.

G. WARRANTY, SERVICE AND MAINTENANCE

Provide a one-year warranty of the installed system, against defects in material and workmanship. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra charge to Owner for parts or labor.

END OF SECTION 270640

SECTION 27 52 23 - NURSE CALL

1. GENERAL

A. RELATED DOCUMENTS

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

B. SUMMARY

- (1) Section includes wiring and components for complete nurse call system.

C. SUBMITTALS

- (1) Product Data: For each type of product indicated.

D. QUALITY ASSURANCE

- (1) Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
- (2) Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this Project and that maintains technical support services capable of providing user with training, parts, and emergency maintenance and repair.
- (3) Source Limitations: Obtain nurses call equipment components through one source from a single manufacturer.
- (4) Electrical Components, Devices and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. COORDINATION

- (1) Coordinate wiring paths and maintenance access at locations listed below. Coordinate trim features and finishes at these locations to present a unified design appearance.
 - a. Main Reception Desk.
 - b. Call stations.
 - c. Zone lights/dome lights.

E. WARRANTY

- (1) Special Warranty: Manufacturer's standard form indicating that equipment carries a five year factory sponsored warranty.

2. NURSE CALL PRODUCTS

A. MANUFACTURERS

- (1) Available Manufacturer's: Subject to compliance with requirements, manufacturers offering products that connect to the existing systems and match existing equipment include the following:

- (2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Rauland-Borg Corporation
 - b. Dukane Corporation
 - c. G.E.

B. EQUIPMENT DESCRIPTIONS

(1) CORRIDOR LAMPS/ROOM CONTROLLERS/ZONE LAMPS

Corridor lamps shall be provided as indicated on the plans and drawings.

a. A LED Corridor Lamps (4-lamp style)

- 1) Corridor lamps shall utilize LED's for high visibility, long life and low maintenance. Corridor lamps utilizing incandescent lamps shall not be acceptable.
- 2) The corridor lamp shall make use of multiple colors and programmable flash rates and patterns to indicate pending calls, service requirements and staff presence.
- 3) Corridor lamps shall serve as the hub for all room wiring. All field wire connections shall be accomplished using modular connectors.
- 4) Any Corridor Lamp shall be able to function as a Zone Lamp that shall visually announce calls from assigned rooms/stations without the use of a Zone Lamp controller such as a duty station.
- 5) The Corridor Lamp shall be equipped with a heart beat LED (visible to service personnel) to indicate that the unit is functioning properly.
- 6) The Corridor Lamp shall accommodate a paper label to indicate the room number. The manufacturer shall provide, at no cost, laser printing template software to create custom room labels. Contractor shall furnish and install Rauland model #CLA244 as shown on project plans and as required by specifications, or approved equal.

(2) Staff Stations:

Staff Stations shall be provided as indicated on the plans and drawings.

a. Staff stations shall be equipped with:

- 1) Pushbutton for call placement.
- 2) Reset button to cancel pending calls. Reset button shall be able to cancel calls from other station in the room if desired.
- 3) Speaker microphone with level matching transformer.
 - (a) Minimum speaker size shall be 3.0"/7.6 cm.
- 4) Green LED to indicate that audio to the station is active.
- 5) Red LED(s) to indicate call placement.

(3) Patient Call Cords:

Patient Call Cords shall be provided as indicated on the plans and drawings. All Patient Call Cords shall be UL 1069 listed as an integral part of the core system. Devices which carry only component listings or are otherwise not part of the core system UL listing are not acceptable.

- a. Standard Call Cords – Standard Call Cords shall be pendant type with a single easy to activate call button, DIN style male plug and sheet clip. Cable shall be a minimum of 10' / 300cm. Contractor shall furnish and install Rauland model #CCDIN as shown on project plans and as required by specifications, or approved equal.

3. EXECUTION

A. SUPERVISION

System shall be installed, maintained and serviced by or under the supervision of manufacturer certified technicians

B. IN-SERVICE TRAINING

The System Supplier shall provide thorough training of all staff assigned to those units receiving new staff/patient communications equipment.

C. ELECTRICAL POWER CONNECTIONS

- 1) It shall be the responsibility of the Contractor to provide a dedicated 120 VAC, 60 HZ conduit feed into the equipment cabinet. This power feed shall not have any other devices connected directly to it. A 20 AMP circuit breaker located in the electrical sub-panel labeled "nurse call" will control this circuit. This electrical circuit will be connected to the facility's power system.
- 2) Connect all network system power supplies and equipment cabinets to a common earth ground utilizing a 12 AWG, or larger, solid conductor which is at minimum the same conductor size as the AC feed wires.

D. PROTECTION OF NETWORK DEVICES

Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

E. CLEANING AND PATCHING

- 1) It shall be the responsibility of the System Supplier to keep their work area clear of debris and to clean the area at completion of work each day.
- 2) It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.

F. DRAWINGS

Provide as built drawings of all installed network components and associated wiring on building plans. Final payment for work will not be authorized unless these drawings are supplied.

END OF SECTION 275223

SECTION 281600 - INTRUSION DETECTION SYSTEM

1. GENERAL

Each Contractor's attention is directed to General Provisions, and all other contract documents as they may apply to his work.

A. General Requirements

- (1) The Security System shall include all items, articles, materials, necessary for a complete system, including all labor, materials, cabling, equipment and incidentals necessary and required for a complete and operating security system.
- (2) This contract includes consulting with the Owner as needed to coordinate receiving services, to allow proper connections to any new or existing monitoring service the Owner wishes to use and to the new access control system. Verify these services prior to bid and include any connection costs and the first year's monitoring fee in this contract.
- (3) Telephone communication to the local security service will be furnished and installed by Contractor. Provide all needed equipment, telephone lines and one year of service in this contract.
- (4) All software programming will be done by Contractor. Each device shall be configured as an individual zone to the panel.
- (5) Wiring charts will be provided by Contractor as to what sensor will be wired to what channel, to suit Owner's requirements.
- (6) All labeling of the LED displays and control panels will be by Contractor.
- (7) Extent of Intrusion-Detection security system work is indicated by drawings and schedules. This system will consist of arm/disarm card swipes, door position sensors, alarm sirens, data gathering control panel and remote annunciator and communication with the access control system.
- (8) Provide software applications for security system, capable of detecting and transmitting security breach by means of cables to data gathering panel for processing and response by panel and distribution to the remote annunciator and sirens as required, as well as off-site notification to the monitoring service as requested by the Owner.
- (9) Work of this section includes wires/cables, raceways, electrical boxes and fittings, as specified in other sections of these specifications.

2. SCOPE OF THE WORK

A. The Contractor shall provide the necessary labor, materials, services and coordination with the Owner and equipment supplier to provide the complete security system indicated on the plans and specified herein. The work shall include, but is not necessarily limited to:

- (1) All necessary conduit, panels, boxes, power connections, etc., as required.
- (2) Cover plates, cabling, testing, terminations, adjustment of devices to ensure adequate coverage patterns.

- (3) The Contractor shall insure that all work is scheduled and accomplished on a timely basis so as not to delay any other parts of the construction.
- (4) Warranty on complete system, unconditional, for a period of one year from final acceptance of the installation.

3. INSTALLATION

- A. The Contractor shall provide all instruments, wiring, lightning surge suppression on incoming lines and connections required for the security system.
- B. The Contractor shall install conduit system for all devices, minimum of 3/4". Contractor shall provide power connections to security devices as required.

C. Cabling

- (1) A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance.
- (2) All cabling shall be concealed, run in conduit from flush-mounted device outlet box to system, then home to control units thru approved conduit.
- (3) Wire/cable manufacturers shall be Belden, West Penn, Alpha or approved equivalent.
- (4) All cabling shall be stranded - No solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation.
- (5) All cable connections shall be continuous run (including shield) whenever possible. Any junctions of cable conductors or shield shall be made in a metal enclosure, soldered and taped. No mechanical connections will be accepted. The size of cabling shall be a minimum of 22 gauge. All cables will be labeled (on both ends and at each junction) as to the area served with a permanent type of labeling system.

D. Electrical Wiring System

- (1) Power for control panel(s) shall be fed from a circuit or circuits from an electrical distribution panel and shall not be taken from receptacles, lighting, or equipment circuits. The circuit(s) within the electrical distribution panels shall be marked "Intrusion Detection System" taken from the indicated 120V power panel (TR1) in the building, on dedicated circuit(s).

E. Equipment

- (1) Manufacturers

In order to set minimum standard of quality, operation and features/options a product brand is named. The manufacturer ADEMCO Series VISTA 4140XMPT is specified. Alternate equipment may be submitted for approval to bid to the Engineer in writing 10 days prior to project bid date. Submittals must contain full engineering data, operators manual, list of differences from the specified system, list of existing systems in operation. Any approved systems shall be equivalent in every feature to the specified system whether or not specifically called for herein. Subject to compliance with requirements, provide security system products of one of the following (for each type of product):

a. Alternate Security System Manufacturers:

Ademco, Moose-Airitech, Simplex

(2) Intrusion Detection Security Systems

- a. General: Provide security system, of types, sizes, capacities and electrical characteristics indicated, consisting of remote arm/disarm card swipes with remote annunciators, data gathering panel as required, connection to Owner's required off-site monitoring service, alarm sirens, signal transmission lines, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard security system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide security systems with following functional and construction features as indicated.
- b. System Control Panel: ADEMCO VISTA 4140XMPT with built in digital communicator, 12vdc 6.0 gel cell back up battery rechargeable, auxiliary power output of 12vdc 700 mA, with circuits that are thermal breaker protected. System shall be furnished with 64 alarm receiving zones active. System shall allow customized zone descriptions. These descriptions shall be chosen from a library of words. The display shall be backlit for easy viewing in the dark. The system shall be capable of downloading via modem or programmed from the keypad. Qualified service representatives shall perform the programming of the system via modem. The system shall be capable of supporting wireless, hardwired and multiplexed alarm zones. The system shall be capable of up to 8 partitions as required, with up to 128 user codes, with ability to log 224 events. The system shall contain #4152LMPO loop module as required to support the multiplex cable system with #4190WH RPM end of line supervisory resistors as required. Supplier shall utilize a 4201 RPM programer for all points in the system that do not utilize a DIP switch. Further, the system shall contain #4197 polling loop extender as required for long cable runs to support data transmission and reception.
- c. Remote Consoles: Shall be ADEMCO 5137AD with a two-line. 32 character supertwist Alpha display, with custom description programmed for each protection point. The console shall have soft, backlit pushbutton keys that provide both tactile and audible feedback. The 5137 shall have a built-in sounder and two status LED's which show if power is present (Green) and system armed (Red). The unit shall be the addressable version provided with a flush mount kit number 513TRK.
- d. Point I.D. Transponder: Shall be ADEMCO 419WH 2-point Remote Point Module with all zones supervised via end of line resistors.
- e. Group I.D. Transponder: Shall be ADEMCO 4208 8-point Remote Point Module with all zones supervised via end of line resistors.
- f. Alarm Sirens: Furnish as shown on the project drawings. Alarm sirens shall be ADEMCO model 740 High intensity sounder mounted in R440SC heavy gauge steel enclosure, with tamper proof switches. Note that this unit shall have conduit installed from the data gathering panel to the Siren enclosure and be grounded according to code requirements. Siren shall require no more than 60mA @ 6 volts DC to emit a high frequency, piercing sound. Zone sirens into the area zone configuration.
- g. Sounding Devices/Sirens: Shall be ADEMCO model 747 self contained siren with a 95dB output at 12vdc.

(3) Security System Cabling And Accessories

a. Alarm Cable: Furnish and install cable as shown on the project drawings and required by local code requirements and the equipment manufacturer. The field cable shall be twisted pair minimum, #16 AWG, stranded, with outside jacket, no shield. One pair to be used for data while the other shall be used for power distribution for field alarm devices. This cable shall be N.E.C. 800 and U.L. listed for use as a security cable in an air plenum space. This cable shall be provided for all system functions including, but not limited to:

- 1) Multiplexed alarm zones
- 2) Hardwired alarm zones
- 3) Remote arm/disarm key pad (home run to panel)
- 4) Remote alarm annunciator (home run to panel)
- 5) Alarm siren as shown on the project plans (home run to panel)
- 6) Main telephone board

4. EXECUTION

A. Examination

- (1) Examine areas and conditions under which Security system is to be installed, and correct conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Installation Of Security Systems

- (1) Install security system, including components where indicated, in accordance with equipment manufacturer's written instructions, in compliance with National Electrical Code, and with recognized industry practices, to ensure that system complies with requirements and serves intended purposes.
- (2) Use care in handling, fishing and pulling-in electronic cable to avoid damage to cable and shielding. Avoid excessive and sharp bends.
- (3) Install equipment properly to avoid causing mechanical stresses, twisting or misalignment of equipment being exerted by clamps, supports, and cabling.
- (4) Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified on U.L. Standards 486A and B, and the National Electrical Code.

C. Grounding

- (1) Provide equipment grounding connections for security system as indicated. Tighten connections to comply with tightening torques specified in U.L. lighting and standards assuring permanent and

effective grounds. Provide a dedicated isolated ground from the equipment data gathering panel to the incoming main electrical service ground.

D. Adjusting And Cleaning

- (1) Set field-adjustable security system components for input voltages, current settings and frequency settings. Set the I.D. numbers for the data gathering panel and the field devices. Provide a complete patching and connection map for the system, posted at the main panel location.
- (2) Touch-up scratched and marred surfaces to match original finishes; remove dirt and construction debris.

E. Demonstration

- (1) Upon completion of installation of security components, and after circuitry has been energized with normal power source, test security system to demonstrate capability and compliance with requirements including, but not limited to; test the operation of each alarm device, as well as the proper annunciation of that device at the remote annunciator.
- (2) Contractor shall perform in-service training for the Owner's representatives for at least six hours. Contractor shall set an appointment for this training with the Owner one week in advance. Engineer shall be similarly notified of this in service training.

END OF SECTION 281600

SECTION 282300 - DIGITAL VIDEO SURVEILLANCE SYSTEMS

1. DESCRIPTION OF SYSTEM COMPONENTS

The digital surveillance system shall consist of the following components:

- A. Digital Camera Server(s) of configuration shown on drawings or specified herein, with all server software installed and pre-configured to be operational automatically upon system start-up. Software shall support camera control and connection, PC screen displays, analog TV displays, automated recording and archiving of camera input, and automated communications. Provide keyboard and mouse. A 17" color PC monitor shall be provided by the installer at each head-end. No external video file or image server and internet or network connection shall be required for full operation of the digital surveillance system.
- B. Remote Access Software utilities with password protected access to the camera server application via dial-up phone connection, Ethernet LAN or WAN. The Remote Access Software provided with the digital surveillance system will not be restricted from being copied or freely distributed and can be operated on any compatible PC.
- C. Video Player utility for point-and-click access to stored video files based upon time, date, and camera graphical screen displays. Video files will be capable of being viewed on any MS-Windows environment video player and images will be capable of being captured and viewed by any MS-Windows image viewer. The video control software provided with the digital surveillance system will not be restricted from being copied or freely distributed.
- D. Provide a battery backup uninterruptable power supply with adequate surge suppression to protect computer equipment. Unit to be sized to run all cameras, power supplies, server(s), and monitor for 15 minutes during a utility outage.
- E. All cameras, power supplies, mounts, controllers, cabling, raceways, labor, testing, owner training, etc., as required.

2. DESCRIPTION OF SYSTEM OPERATION

The system shall provide for unattended operation of the following features contained within video server(s) without the need for networked external or off-site devices. In summary, the digital surveillance system shall provide for:

- A. Digital monitoring, recording, playback, and remote observation for the number of cameras noted, continuously and simultaneously.
- B. Digital recording, playback, and file archiving self-contained within a single location of camera server(s).
- C. Multiplexed video monitoring options plus additional analog remote display outputs
- D. Video motion sensing, alarm response, paging, e-mail, and remote monitor site alerting administered by operator selections or automated timers and schedulers.
- E. Remote access capabilities to include choice of multiplexed viewing, recording, camera control, playback, and program administration with secure password protection.
- F. Plug-and-play ethernet (TCP/IP), POTS dial-up, ISDN and PPP Internet connectivity.

- G. Provide remote duplicate monitoring with "dumb" terminal (specifically made for the task) remote console at reception desk. Remote duplicate monitoring may also be accomplished over the building data network via software.

3. CAMERA SERVER SYSTEM STANDARDS

- A. The system shall be compatible with Windows XP or Vista, with both graphical interface for monitoring and control and MS-Windows utilities for operation and setup. It shall be capable of operating on Windows NT and Novell networks allowing remote access over customer computer networks.
- B. The system and software shall support connection of the noted number of cameras with the capability of recording full-stream video of all cameras concurrently, provide display of each camera view as multiple images on an industry standard PC monitor, record digital files for each camera to DVR, DVR shall have the option to back up to CD/DVD and to USB Hard Drives/Thumb Drives. DVR to have a 2 Terabyte Hard Drive for video storage.
- C. The system shall utilize the US-NTSC standard for all video signal input and the system shall be compatible with color CCD cameras supplied with the system.
- D. The system shall be capable of recording and storing compressed digital video files and decompressing files for playback using high-resolution compression technology. Transmission of video for remote access will default to high frame rate H.263 compression. In addition, the system will be capable of saving files as uncompressed .AVI or capable of saving images to TIF files compatible with MS-Windows graphics, video playback, or image enhancement software.
- E. The system shall support remote access of video via POTS or ISDN telephone lines using PC-compatible modems, via Ethernet when connected to a 10/100-baseT LAN or WAN, or via internet connection using an Internet Service Provider. Both telephone dial-up and network TCP/IP remote connections shall be independently selectable and enabled with password protection to eliminate unauthorized access. Provide a proper Ethernet connection at each head-end location from existing hub or switch facilities, using Category 6 cable, RJ-45 jacks and a patch cable. The Owner shall configure the new address into the local area network.
- F. Remote access shall be from a PC-compatible computer (meeting minimum requirements) using an included remote access program. No browser software or internet connection shall be required.
- G. Backup of all video files created within a 24 to 48 hour period shall be automatically accomplished at a predetermined hour each night without user action required. The camera server application and all operation of the server shall not be interrupted or degraded in performance while the backup is being performed. Files archived shall be able to be retrieved by any camera server or PC with the player software installed. Archive capacity shall be determined by the characteristics of the video as it is recorded and shall be user controllable. DAT tape shall be provided with capacities capable of up to 70 gigabytes per tape as specified or indicated. Provide three tapes for each drive.
- H. System shall be of robust design, capable of 7x24 unattended operation with auto-recovery after extended power interruption. Make an interlock/control connection to battery U.P.S. backup unit. The system shall communicate with the UPS for orderly shutdown and restart.
- I. By default, the system shall offer password protection to access system administrator tools or for remote connection authorization. Multiple levels of password protection shall be selectable by user name.

4. CAMERA (VIDEO) SERVER OPERATING SPECIFICATIONS

- A. Systems shall be offered for plug-and-play installation direct from the manufacturer. All operator tools shall be of graphical interface or easily understood Windows toolsets using a PC mouse.

- B. Standard capabilities shall allow for immediate display of camera views with the system automatically in operation as long as power is connected. Further access to administrative functions shall require password access, as well as password access being required before the server system will acknowledge a request for remote surveillance connection.
- C. Server display will allow for choice of display formats from one to nine or sixteen cameras. The direct view through the server's monitor shall feature a digital TV quality overlay of all camera views. In addition, scanning views of specific cameras may be played on the screen as well as being directed to a standard TV set having a video input jack. Specific views may be enlarged to full screen by mouse click.
- D. Video recording and display characteristics shall be administrator selectable for each camera as follows: Image resolution shall be capable of at least 640x480 pixels with lower selectable alternatives; time lapse frame rate shall be adjustable from one second up to the maximum noted in the system specifications and video compression ratio shall be selectable up to 1:60. Each reduction in image quality or frame speed shall allow for greater storage capacity.
- E. Camera characteristics shall be capable of matching all NTSC standard camera types.

5. SYSTEM SECURITY FUNCTION SPECIFICATIONS

- A. System shall be capable of beginning recording and creating alarm notifications as a result of detecting motion through attached cameras. Detection shall be specified on a camera-by-camera basis using customizable screen trigger templates. Motion detection shall be activated by manual input, by user determined time-of-day/day-of-week scheduling, or by external security triggers or motion sensing devices providing closed-contact indication.
- B. When activated by motion, the camera server shall be able to trigger up to 4 external alarm panels or devices via contact closure. The camera server's operation shall be triggered by incoming contact closure connections. Refer to the drawings or other section of this specification for alarm details.
- C. Alarm notification shall include generating a telephone page immediately upon motion detection trigger or contact closure trigger. Response (although dependent upon the user's service) will be capable of a notification being received within one minute of the trigger event. Up to three page numbers shall be polled until a connection is made by the camera server. The Contractor shall provide a telephone circuit from the telephone service location to the server location and connect. The Owner will indicate the specific circuit to be used.
- D. Alarm notification shall include activating the remote video monitoring software automatically via POTS dial-out call or TCP-IP log-in connection. Up to three sites shall be polled until a connection is made by the camera server.
- E. Additional alarm notifications shall include audible alarm output from the camera server using a Windows WAV file selectable by the administrator. Visible screen alerts shall direct attention to the camera view causing the triggering event.
- F. The camera server shall log all events including camera triggering, system on and system off, username/password login events, remote connections made. In addition, the capability to create exception logging of video files created under specific pre-determined situations (accessories required to generate the exception logging event).
- G. System shall generate complete time/date/camera stamp on monitoring views, playback views, still frame printed output, and stored video files. The time/date stamp data will be permanently incorporated as a component of the video image and shall be generated in black or silver with position directed to any of the four image corners.

6. VIDEO STORAGE AND PLAYBACK SPECIFICATIONS

- A. Playback of any stored video file (or any other administrative activity) shall cause no interruption or degradation of performance of the camera server operation.
- B. Video playback shall be facilitated through the use of a graphic appearing Windows-style VCR control screen or approved equivalent with mouse-click command response that allows easy access to video files using a calendar date, time, and camera data table. Files listed shall be able to be played and viewed immediately by simply clicking on a selected file that opens as any other windows video file. Single files or lists of files shall be able to be viewed as real-time, time-lapse, fast forward or reverse, and still frame. Images shall be able to be directly printed using any PC printer attached to the camera server. Printer, if any, shall be furnished by Owner. System shall also be capable of communicating with a network printer via the provided 10/100t ethernet network interface card.
- C. Recorded digital video files shall be stored for direct access and playback on computer hard drives of the size specified. The amount of time available directly on the hard drive depends upon the recording schedule, image resolution, compression, and frame rate chosen in system setup. This can be from several days (high frequency of recording, high resolution, and high frame rate) to several weeks (low occurrence of motion, time lapse and lower resolution) depending upon the user's preference. This shall be reconfigurable by the Owner via on-screen controls.
- D. Recorded digital video files shall be archived on high-capacity DAT tape for easy recovery and playback. Backup Executive software shall allow for unattended backup and assisted recovery of archived periods of time by calendar date restoration. Once restored from archive, files shall be ready for playback using the calendar search user interface.
- E. Video Player software module required for playback shall not be copy protected and shall not be licensed for distribution. It shall be capable of being duplicated freely.
- F. Video files created by the system shall be capable of being saved as uncompressed, Windows-compatible video (.AVI) files for playback on any MS-Windows PC using the Media Player. The file shall be capable of being played by simply clicking on the filename.

7. OWNERSHIP RIGHTS AND SUPPORT

- A. The system software application license shall be totally user-owned and user-supportable with complete documentation files provided for duplication at will. Reproduction of remote viewing software shall be allowed to enhance the flexibility of remote access to the camera server. Reproduction of the Video Player shall be unrestricted and shall accompany any video files to facilitate viewing. Files may be saved as MS-Windows (.AVI) files at any time.
- B. No additional cost contracts for software support or server maintenance will be required for the first three years. The processor system shall include a complete three-year, on-site, next-business day warranty with optional hardware warranty service extensions available after three years. Future software releases which may include enhancements shall be available at no charge whenever possible. Vendor is to notify Owner via mail, e-mail or phone call of available upgrades during the warranty period.

8. SYSTEM OPTIONS AND ACCESSORIES

The Digital Surveillance System shall accommodate additional capabilities not required for basic operations but that may be required in exceptional situations.

- A. Interface Controller required to connect automated cameras capable of external motion and image control.

- B. I/O Relay Panel for receiving alarms from other devices or outputting alarms to external alarm panels.
- C. Proximity sensing access controllers, microchip proximity tags, cards or badges, and electrically activated door locks to support a safe and controlled-access environment.

9. SYSTEM SPECIFICATIONS

A. LOCAL CAMERA VIEWING

- (1) Camera Inputs NTSC - Number as noted on plans
- (2) Composite Outputs 1 Analog Video Output Multiplexed, 1 Switcher
- (3) Screen Partition 1, 4, 6, 9, 12, 16 with multiple screen patterns
- (4) System Frame Rate 30 Frames per Second / System
- (5) Individual Camera Frame Rate 1-30 fps (averaged over cameras displayed)
- (6) Resolution (pixels) 640X480
- (7) Compression (selectable) 1-20, 1-30, 1-40, 1-50

B. REMOTE CAMERA VIEWING

- (1) Camera Views (selectable) 1-16
- (2) Resolution (selectable) 640X240
- (3) Compression Format Motion JPEG
- (4) Communication (selectable) TCP/IP:LAN, WAN, Internet or Dial-up Phone: POTS / ISDN

C. HARD DISK RECORDER / PLAYER

- (1) Record Speed (selectable) 24 fps (averaged over cameras recorded)
- (2) Cameras Recorded Simultaneously 1-16 (selectable)
- (3) Cameras Played-Back 1-16 (selectable)

D. RECORDING MODES (SELECTABLE ON-SCREEN)

- (1) Motion Triggered (Timed Scheduled)
- (2) Constant Record (Timed or Manual)
- (3) Contact Triggered (Timed Scheduled)
- (4) Monitor Mode Only (Screen Display)

E. CPU

- (1) Processor 700 MHz (min) Pentium III
- (2) RAM 128 Mb
- (3) Video 16 Mb
- (4) Standard Storage DVR w/2 Terabyte capacity
- (5) Archived Storage CD/DVD and USB Hard Drives/Thumb Drives
- (6) Communications 56Kb Modem, 10/100mb Ethernet Card

10. EQUIVALENT PRODUCTS

- A. Other technologies or systems that do not exactly meet the requirements of this section, that are truly equivalent digital video solutions will be considered as acceptable for this project. Contact the Engineer ten working days prior to the bid date to obtain permission to bid in a written addendum.
- B. Equivalent systems that meet the specification requirements as manufactured by R.T.I., Panax, Honeywell or Panasonic will be acceptable.

11. CAMERAS AND VIDEO DISTRIBUTION SYSTEM

A. GENERAL REQUIREMENTS

- (1) It is the purpose and intent of this specification to obtain for the Owner a complete, high quality, reliable analog camera and video distribution system.
- (2) All necessary equipment, material and labor shall be provided by the Contractor, whether or not specified. All workmanship shall be neat and of the highest quality and conform to prevailing standards.
- (3) The system shall be comprised of completely matched and video service compatible components. Any equipment catalog numbers listed constitute the type and quality of the equipment to be furnished. Other manufacturer's equipment will be acceptable if all performance requirements of this specification are provided.
- (4) All equipment shall be supplied by a factory authorized dealer. In order to assure the Owner of factory warranties, the equipment supplier shall be prepared to provide factory authorization. A supplier not authorized by the manufacturer to furnish the specified equipment will not be acceptable.
- (5) The camera specified is based on equipment manufactured by "Silent Witness." Other systems or equipment as manufactured by Pelco, Burke, Panasonic, Sony, etc., will be acceptable, if provided by authorized dealers of said equipment.

B. QUALITY ASSURANCE

- (1) Distributor must have at least 3 years of successful installation experience with products utilizing CCTV equipment similar to that required for this project.
- (2) Contractor must comply to all applicable requirements of NEC Article, 300, 800, 810 and 820 pertaining to radio and TV equipment and signal distribution systems.
- (3) Equipment must comply with applicable requirements of UL standards 813 and 983 pertaining to television equipment and accessories which are UL listed and labeled.

C. EQUIPMENT

- (1) CCTV Cameras
 - a. The color cameras shall be analog and use a 1/3 inch format, interline transfer, CCD image sensor containing the specified number of active picture elements.
 - b. Camera shall have 420 (indoor) 420 (outdoor) minimum lines of resolution with a minimum object illumination of 1.0 lux at F2.0.
 - c. Camera shall have back focus, line back phase sync adjustments.
 - d. Provide fixed lens with auto iris (mechanical or electronic) of the proper millimeter size for best viewing scene for each camera location at indoor and outdoor locations. Lenses shall be provided that fully cover the intended viewing area (140 degree minimum). Adjustments of lens type may be needed in the field and shall be anticipated in the bid.
 - e. Camera shall be 12 to 24 volt AC or DC equal to Silent Witness, Pelco, Sony, Panasonic.

- f. For each outdoor infrared camera, provide 12 to 24 volt power with remote power supply for housing blower, heaters, etc., as required. Also provide a properly grounded lightning arrester on the coaxial cable lead-in and the power wiring just inside building entry. Provide 24 volt power to outdoor cameras using discrete power supplies compatible with the camera. Power supply(ies) shall be located at or near at head-end locations. If in doubt about the installation, contact the Engineer for clarification. All wiring for 24 volt power shall be sized per N.E.C., to keep voltage at terminal point within camera operating parameters.
- g. Each camera shall generate a custom unique alphanumeric identifier, visible on any monitor or recorded image. This identifier shall be as requested by the facility operator.

(2) Camera Enclosures

- a. Indoor camera enclosure shall be a semi-recessed dome ceiling type with the necessary adjustment radius. Provide tile bridge or rails to support in lay-in ceilings. Domes shall be lightly tinted to hide camera orientation.
- b. Provide all enclosures with vandal and tamper resistant construction.
- c. At exterior camera locations, provide weatherproof vandal-resistant housings with powder coat finish, color selected by Engineer, with companion painted mounting plate for roof or parapet installation. Also, provide housing with heaters and defrost blower unit.
- d. At indoor surface mounted exposed camera locations, provide an adjustable heavy-duty wall bracket mount.

(3) Cable

- a. Provide RG6/U type, plenum-rated where required, 75ohm impedance with copper center conductor, plus 2-18 gauge jacketed, stranded conductors for low voltage power, plenum-rated where required.

D. EXECUTION

- (1) The installation of all work shall be neat and of professional quality. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment. Install so as to eliminate EMI/RFI effects.
- (2) The Contractor shall provide conduit systems to junctions and mount all boxes for the systems wiring as indicated on plans. Special boxes shall be provided by the systems supplier for installation by the Contractor.
- (3) Upon completion of the installation, the system shall be tested by the manufacturer's representative and all necessary modifications and/or adjustments must be made to assure compliance with this specification.
- (4) Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.
- (5) The work shall include supplying the services of a field service representative who shall be a full-time employee. The field service representative shall have specialized experience in the operation and maintenance of the system and shall instruct the Owner's personnel in the techniques involved in the operation of the systems. A formal on-site training shall be provided to the Owner's representative/maintenance personnel and shall include instructions in the location,

inspection, maintenance, testing and operation of all components. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the Owner. The training session shall be a minimum of three hours at each facility or with each individual or group of personnel being trained.

- (6) All cameras shall be connected to digital video server(s) and power supplies in proper fashion, in compliance with N.E.C.

E. WARRANTY, SERVICE AND MAINTENANCE

- (1) Provide a three year unconditional warranty of the installed camera system, against defects in material and workmanship. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra charge to Owner for parts or labor.
- (2) The CCTV supplier shall employ factory trained technical service personnel for service and maintenance of the system should service be required. The supplier shall also instruct the Owner's technical personnel in the operation, care and maintenance of the system.

END OF SECTION 282300

SECTION 283100 - FIRE ALARM SYSTEM

1. GENERAL

A. SCOPE AND RELATED DOCUMENTS

- (1) The work covered by and the intent of this section of the specifications includes the furnishing of all labor, equipment, materials, testing, programming and performance of all operations in connection with the installation of the Fire Alarm System as shown on the drawings, as herein specified and as required by the applicable codes.
- (2) The requirements of all other applicable conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
- (3) The complete installation shall conform to the applicable sections of NFPA-71, NFPA-72A, B, C, D, Local Code Requirements and National Electrical Code (Article 760). The requirements of any local fire department and the Authority Having Jurisdiction shall also be observed in the system installation and device layout.
- (4) The work included in this section shall be coordinated with related work specified elsewhere in these specifications.

B. QUALITY ASSURANCE

- (1) Every component, device, transmitter, software, etc., that are included in the work, to make up a complete Fire Alarm System shall be listed as a product by the manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label.
- (2) The system power, signal and controls wiring shall be UL listed for Power Limited Applications per NEC 760. All circuits shall be marked in accordance with NEC Article 760.

C. GENERAL

- (1) Furnish and install a complete digital multiplex Fire Alarm System as described herein and as shown on the plans; to be wired, connected, completely tested, and left in first class operating condition. The system shall use individually-addressable digital multiplex device circuit(s) with individual device supervision, appliance circuit supervision, incoming normal and stand-by power supervision. In general, systems shall include a control panel, manual pull stations, automatic fire detectors, horns, flashing lights, annunciator (if indicated), raceways, all wiring, connections to devices, connections to valve tamper switches, water flow switches and mechanical controls, outlet boxes, junction boxes, and all other necessary materials for a complete, operating system.

The fire alarm control panel shall allow for loading or editing of any special instructions or operating sequences as required. No special tools, modems, or an off-board programmer shall be required to program the system to facilitate future system expansion, building parameter changes, or changes as required by local codes. All instructions shall be stored in a resident non-volatile programmable memory.

- (2) All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name of each component. Any catalog numbers specified under this section are intended only to identify the type, quality of design, materials, and operating features desired.

The listing of specific catalog numbers and equipment parameters is not intended to limit competition among other manufacturers that propose to supply equivalent equipment and services. Fire alarm systems as manufactured by Simplex, Siemens/Cerberus, Edwards, Thorn or Notifier will be acceptable.

- (3) Equipment submissions for shop drawing review must include a minimum of the following:
- a. Complete descriptive data indicating UL listing for all system components.
 - b. Complete sequence of operations of the system.
 - c. Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.
 - d. A copy of any state or local Fire Alarm System equipment approvals.
 - e. An Autocad (latest version) produced wiring diagram illustrating the basic floor plan of the building, showing all system wiring and equipment, as well as zoning boundaries and schedule of zone legends as intended to appear on annunciators. Provide three CD-Rom copies of as-built drawings and all system operational software at close of project, to be included in operation and maintenance manuals.
- (4) No work shall be done until the drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

D. OPERATION

- (1) The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
- a. 1) The appropriate initiating device circuit indicator (red color) shall flash on the control panel until the alarm has been silenced at the control panel. Once silenced, this same indicator shall latch on. A subsequent alarm received after silencing shall flash the subsequent zone alarm indicator on the control panel and resound alarms and flashing signals. These same conditions shall occur at any remote annunciator.
 - 2) A pulsing alarm tone shall occur within the control panel until silenced.
 - b. All alarm indicating appliances shall sound in a temporal code pattern until silenced by an alarm silence switch at the control panel (or the remote annunciator, if any).
 - c. All doors normally held open by door control devices shall close. Doors shall also be released in the event of incoming normal power failure.
 - d. A supervised signal to notify the local fire department or an approved central station (as required by local codes) shall be activated.
 - e. A supervised signal shall directly activate, shut down or reconfigure the air handling systems as required by NFPA or as otherwise indicated herein. Provide necessary interlock wiring as required to control mechanical equipment.

- f. The Contractor(s) shall coordinate with each other as necessary to provide all required auxiliary contacts, DDC systems interfaces, equipment, etc., as needed to shut down or otherwise control air handling systems per NFPA and all applicable codes.
 - g. The system shall be wired with two circuits to all Notification devices so that when an alarm is acknowledged, silencing the audibles, the visual units shall continue in operation until the main control panel has been reset. If local codes require other than this arrangement, the system shall be wired in accordance with the code that is applicable.
- (2) The alarm indicating appliances shall be capable of being silenced only by authorized personnel operating the alarm silence switch at the main control panel or by use of a similar key operated switch at the remote annunciator (where remote units are provided). A subsequent alarm shall reactivate the signals. Operation of the alarm silence switch shall be indicated by trouble light and audible signal.
- (3) The alarm activation of any elevator lobby shaft, pit or equipment room smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:
- a. If the alarmed detector is in any location or on any floor other than the main level of egress, the elevator cars shall be recalled to the main level of egress.
 - b. If the alarmed detector is on the main egress level elevator lobby, the elevator cabs shall be recalled to the pre-determined alternate recall level.
 - c. Provide auxiliary contacts within the base of each elevator lobby smoke detector, with each separate landing to be wired back separately to the elevator controller. Coordinate all equipment terminations and sequence of operation with the elevator installer. The use of digital to analog controllers to accomplish this function will be acceptable, if in compliance with codes.
 - d. Provide heat detectors within 12" of each sprinkler head where they are installed in elevator equipment rooms, shafts or pits, in accordance with code. The temperature rating and wiring of the detectors shall be coordinated with the sprinklers, per ANSI Elevator Code and NFPA. Wire to interrupt elevator power per the applicable code.
- (4) The activation of any standpipe water valve tamper switch or sprinkler zone valve tamper switch shall activate a distinctive system supervisory audible signal and illuminate a "Sprinkler Supervisory Tamper Switch" indicator at the system controls (and the remote annunciator[s]). There shall be a distinction in the audible trouble signals between valve tamper switch activation and opens or grounds on fire alarm circuit wiring.
- a. Activating the trouble silence switch will silence the supervisory audible signal while maintaining the "Sprinkler Supervisory Tamper" indicator showing the tamper contact is still activated.
 - b. Restoring the valve to the normal position shall cause the audible signal and visual indicator to pulse at a fixed rate.
 - c. Activating the trouble silence switch shall silence the supervisory audible signal and restore the system to normal.
- (5) Include with the control panel, as an auxiliary function, a built-in test mode that, when activated, will cause the following operation sequence:

- a. The city connection circuit shall be disconnected.
 - b. Control relay functions shall be bypassed.
 - c. The control panel shall show a trouble condition.
 - d. The panel shall automatically reset itself.
 - e. Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for a minimum of two seconds to indicate the trouble condition.
- (6) A manual evacuation switch shall be provided to operate the system indicating appliances and/or initiate "Drill" procedures.
- (7) Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system and initiate a trouble condition at the control panel.
- (8) Include any and all detection equipment and interface relays as required to provide a 100% code approved and supervised pre-action Fire Suppression system. Coordinate with the Fire Protection installer as required.

E. SUPERVISION

- (1) The system shall contain Class "B" (Style "B") independently supervised initiation circuits as required for the zoning indicated. Circuits shall be arranged so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- (2) There shall be supervisory initiation circuit(s), as required, for connection of all sprinkler valve tamper switches. Wiring methods which require any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e., sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). These independent initiation circuit(s) shall be each labeled "Sprinkler Supervisory Tamper Switch" and shall differentiate between tamper switch activation and wiring faults. Provide individual annunciation for the main post indicator valve and each tamper switch as indicated by the zoning schedule on the plans or as otherwise required by codes. For these circuits and all exterior underground copper circuit wiring, provide proper surge suppression and protection for circuit.
- (3) There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps.
- (4) All auxiliary manual controls shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble.
- (5) Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to indicate disarrangement conditions, per each circuit.
- (6) The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel and the annunciator. A green color "power on" indicator shall be displayed continuously while incoming power is present.

- (7) The system batteries shall be lead-acid type, supervised so that disconnection or failure of a battery shall be audibly and visually indicated at the control panel (and the annunciator).
- (8) Wiring to the remote annunciator shall be supervised for open and ground conditions. An independent annunciator trouble indicator shall be activated and an audible trouble signal shall sound at the control panel.

F. POWER REQUIREMENTS

- (1) The control panel shall receive 120 VAC power via a dedicated circuit. The incoming circuit shall have suitable overcurrent protection within the control panel, as well as at the circuit source. If additional circuits are required for this or other control units, they shall be provided by the Contractor.
- (2) If the facility is equipped with an emergency standby power generator, the fire alarm equipment shall be connected to this system, per N.E.C.
- (3) The system control panel and auxiliary equipment, such as power supplies shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of time as required by codes for the building occupancy. There shall be reserve battery capacity to drive all alarm appliances for five minute indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operating shall be automatic. Batteries, once discharged, shall recharge at a rate that will provide a minimum of 70% capacity in 12 hours, or sooner if required by codes.
- (4) All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.
- (5) Power supplies for Notification signals, whether in the main panel or within remote power supply cabinets, shall be designed to provide a minimum of 20% spare capacity for future signals.

G. FIRE ALARM CONTROL PANEL

- (1) Where shown on the plans, provide and install the Fire Alarm Control Panel. Construction shall be modular with solid state, microprocessor based electronics. All visual indicators shall be high contrast, light-emitting diode type.
- (2) The control panel shall contain the minimum following features as per plans:
 - Minimum Capacity of 120 Control or Monitor Points or greater, to Suit Building Requirements, expandable to 1000 points
 - Initiation Device Circuits
 - Alarm Indicating Appliance Circuit
 - Supervised Annunciator Circuits
 - Local Energy City Connection, if required
 - Form C Alarm Contacts (2.0 Amps ea., minimum of two unless otherwise required)
 - Earth Ground Supervision Circuit
 - Automatic Battery Charger, of proper rating
 - Standby Battery, Lead/Acid Type
 - Resident non-volatile programmable operating system for all operating requirements
 - Supervised Manual Evacuation Switch
 - Internal power supplies as required for auxiliary functions as indicated

- Auxiliary contacts or relays for auxiliary functions as indicated
- All Custom Software and Programming as required to suit the project requirements

H. SYSTEM SOFTWARE AND PROGRAMMING

- (1) Provide all programming and software necessary to place annunciators and controls in full operation. System set-up shall allow for changes in annunciator legends without rewiring or addition of programming or electronics. Furnish initial programming and reprogramming as needed to accommodate changes in the system up to the time of system acceptance by the engineer without extra charge.

I. REMOTE ANNUNCIATOR

- (1) Where indicated on the plans, provide and install annunciator/control panel. The panel shall be of vandal-resistant construction and shall contain a liquid crystal illuminated display for alphanumeric indication of all required functions. The panel shall also contain the following control functions, activated by a master system enable key switch on front panel:
 - a. Remote system reset switch, to complement main control panel reset switch.
 - b. Remote alarm signal silence switch.
 - c. Remote manual evacuation switch, to initiate fire drill functions, same as at main control panel.
 - d. Remote trouble silence switch to silence trouble alarms in annunciator panel and main control panel.
 - e. Install panel on properly sized outlet box, 54" AFF to centerline. Panel shall contain tamper-resistant LED test switch in panel, local audible alarm, system power on, trouble LED indicators and master system enable key switch, keyed alike with the main control panel.
- (2) Annunciator legends shall be custom, to display both zone number and brief legend indicating the area or device associated with that zone. The legends shall be electronically generated on an alphanumeric display panel. The fire alarm system vendor shall coordinate the legends with the Engineer at shop drawing review.
- (3) Wiring between main control panel and annunciator(s) shall be fully supervised, and accomplished over twisted shielded pair and/or THWN wiring as required by the manufacturer, per N.E.C. and NFPA.

J. PERIPHERAL DEVICES

Note: On fully digital multiplex systems, provide addressable devices, bases or modules for devices listed herein. Each device shall be an individual address on the system. Addressable bases or modules shall be U.L. listed for the device served.

(1) MANUAL PULL STATION

- a. Manual stations shall be double action and shall be constructed of high impact, red lexan or cast metal with raised white lettering and a smooth high gloss finish. The manual pull station shall have a hinged front with key lock. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock open in a protruding

manner. Furnish one key for each manual station to owner at close of project, during instruction period. Install within 60" of each exit, per code, whether indicated on the drawings or not.

(2) CEILING-MOUNTED SMOKE DETECTORS, PHOTOELECTRIC TYPE

- a. Furnish and install where indicated on the plans or required, ceiling-mounted smoke detectors. Provide separate outlet-box mounted base with auxiliary relay, or standard base, as required.
- b. Smoke Detectors shall be listed to U.L. Standard 268 and shall be compatible with their control equipment. Detectors shall be listed for this purpose by Underwriters' Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. Loss of the operating voltage shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be capable of being reset at the main control panel.
- c. No radioactive materials shall be used. Detector construction shall provide mounting base with twist-lock detector head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-cleaning contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction, and compatibility with other normally open fire alarm detection loop devices such as heat detectors, pull stations, etc.
- d. To minimize nuisance alarms, voltage and RF transient problems, suppression techniques shall be employed as well as a smoke verification circuit and an insect screen. The detector head shall be easily disassembled to facilitate cleaning.
- e. Remote LED alarm indicators shall be installed where required.
- f. Smoke detectors (and all other system electronics) shall be shielded to protect circuitry from EMI problems generated by power fields, cellular phones, etc.
- g. Special Note: The Contractor installing smoke detectors shall use care in the final positioning of all devices. They shall not be installed closer than 36" from an air diffuser or return grille, closer than 24" from a ceiling/wall intersection, or similar location that would diminish detector performance. Refer to and comply with NFPA 72E, "Standard On Automatic Fire Detectors".
- h. Provide smoke detector at each fire alarm system control component, as required by code.

(3) AUTOMATIC HEAT DETECTORS (RATE-OF-RISE TYPE)

- a. Automatic heat detectors shall be combination rate-of-rise and fixed-temperature type. When the fixed-temperature portion is activated, the units shall be non-restorable and give visual evidence of such operation. Heat detectors shall be 135, 165 or 195NF, as indicated on plan. Where not indicated, provide 165° F units. Provide as indicated or required.

(4) AUTOMATIC HEAT DETECTORS (FIXED TEMPERATURE TYPE)

- a. Where indicated on the plans, provide automatic heat detectors of the non-restorable type, of the temperature rating as indicated or required. Detector heads shall be mounted to an outlet-box mounted base. Provide auxiliary contacts as needed. Provide as indicated or required.

(5) AUDIBLE AND VISUAL UNITS

- a. Audible signals shall be polarized and shall be operated by 24 VDC. Each audible assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors will not be accepted. The audible visual units shall be equipped with a xenon-type strobe which shall be semi-flush mounted on 4" square outlet box. Each audible device shall produce a minimum sound pressure level of 92db at 36" on axis. Provide units as manufactured by Wheelock, Inc., or approved equivalent. Locate as indicated or required. All audible tones for same function shall be identical, per NFPA. Provide sufficient audible units to comply with code for required coverage. Provide temporal coded signals.
- b. The output intensity of all visual units, their locations and mountings shall be in compliance with the latest version of the Americans with Disabilities Act requirements.
- c. Audible units and visual units shall be wired to separate Notification circuits, allowing for silencing of audibles with alarm acknowledgment, continuing operation of strobes until system reset. Addressable devices may be used to fulfill this requirement.
- d. Provide system-wide synchronization of all visual devices, so that all strobes flash at the same rate and at the same time, complying with A.D.A.

(6) VISUAL UNITS

- a. Stand-alone visual indicating units shall be xenon type strobe matching audio-visual units. These devices shall be UL listed and be or wall mounted. A high-impact clear lens shall project out from backplate. Lettering, if any, shall be oriented upright to the standing viewer. Candela output values of all visual units shall be selected for the covered spaces geometry and size, complying with A.D.A. and NFPA.

(7) DUCT SMOKE DETECTORS

- a. Duct smoke detectors shall be of the solid state photoelectric type, operating on the light scattering photodiode principle. The detectors shall ignore invisible airborne particles or smoke densities that are below the set alarm point. No radioactive materials shall be used. The basic construction of duct smoke detectors shall be the same as that previously described for ceiling-mounted smoke detectors. Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm status LED visible through a transparent cover, panel or in housing.
- b. The Contractor shall furnish air duct smoke detectors with template to the sheetmetal or air handling unit installer for installation. Coordinate length of sampling probe required and furnish appropriate length. Probe tube shall be located in accord with manufacturer's recommendations, to give maximum sampling rate of airflow. Provide multiple detectors, as required, if a single device will not provide adequate sensing due to duct size or air velocity. Wire multiple detectors on a single air handling system as a single zone or address unless otherwise required by prevailing codes. Field verify quantity of detectors needed to provide NFPA-compliant coverage of the air handling unit and provide as required.
- c. Detector supervised power and alarm wiring (from F.A. control panel) is to be provided by the Contractor. Interlock wiring from auxiliary contacts to stop or otherwise control air handling unit fan motor(s) is to be provided by the Contractor. Provide auxiliary contacts as required.

Zone wiring and indication for air duct smoke detectors shall be maintained separate from area detection devices. Detector shall be capable of being reset at the main control panel, and at a local test/reset station.

- d. Where air duct smoke detectors are located in other than Mechanical Rooms or in spaces not easily visible, a remote alarm/power indicating LED key reset station shall be installed. These remotes shall be ganged together, if required, and labeled accurately as to which unit is reporting an alarm condition.
- e. Where air duct smoke detectors are indicated to be furnished at concealed air handling units above ceilings or smoke damper locations, furnish as outlined above. Also provide remote indicating alarm LED flush in corridor wall at 7'-0" A.F.F. immediately below installation, or as close as practical to installation. The Contractor is to provide control wiring, E.P. switches, etc., as required to operate smoke dampers, as well as the required operating circuit. Coordinate all requirements with the installer of smoke dampers.
- f. Ionization - type detectors shall not be utilized for air duct smoke detection.
- g. All air duct smoke detector installations and materials shall be in accord with U.L., NFPA, and any other applicable codes.

(8) WEATHERPROOF DEVICES AND EXPLOSION-PROOF DEVICES

- a. Where the anticipated atmosphere or installation conditions require weather-proof, explosion-proof or other specially housed devices, they shall be U.L.-listed and NFPA-compliant and provided as indicated or required. Verify installation conditions and indicate type of device on shop drawing submission.

(9) END OF LINE RESISTOR

- a. End-of-line devices (if required) shall be flush-mounted, located at 7'-0" A.F.F. in corridor walls or as indicated.

(10) GUARDS FOR DEVICES

- a. Where detectors, manual stations, signals, etc., require or are indicated to be furnished with a guard, utilize a U.L. listed unit, compactly covering and compatible with the device. Provide as indicated or required. Guards shall not diminish the performance of any device.

(11) DIGITAL ALARM COMMUNICATOR/TRANSMITTER

- a. Provide a U.L.-listed and NFPA-compliant digital alarm communicator/transmitter (D.A.C.T.). Install at telephone terminal board or telephone service entrance and provide supervised wiring to fire alarm control panel as required. This unit may be semi-flush mounted at the F.A.C.P. location with prior approval by the Engineer. It may also be integrated within the main control panel, if U.L.-listed for the purpose.
- b. The installation and connection of the D.A.C.T. shall be in compliance with all provisions of N.F.P.A. 71 and all other applicable codes. The installation and connection shall be acceptable to the Authority Having Jurisdiction, as well as the telephone company (or companies) over whose lines the signal(s) will be transmitted. Include any costs associated with telephone company work and services required in bid. Telephone connection shall be in compliance with NFPA 71, chapter five.

- c. The D.A.C.T. shall be capable of transmitting all information relative to system status changes due to alarm, trouble, water flow, and any other information as required by current codes applicable to the facility. This information shall be transmitted to a U.L. listed Central Receiving Station, that also is maintained in accord with the requirements of NFPA 71. Connect system to transmit signals as required by local codes.
- d. As a part of this contract, the services of a Central Receiving Station shall be engaged for a period of one year from the date of substantial completion, this date as defined elsewhere in these documents. The Central Receiving Station facility selected shall be in full compliance with NFPA and other applicable requirements. The Contractor shall initiate this service, provided on a contract basis, and shall include any costs associated with this provision in his bid. The actual beginning date of the contract with the central receiving station may be adjusted at the discretion of the Engineer, but in no case shall be for less than one year. The contractor shall notify the owner in writing by certified mail that this service has been contracted for and explain the provisions of this service adequately. A copy of this communication and the return receipt shall be forwarded to the Architect and the Engineer.

(12) REMOTE POWER SUPPLY UNITS FOR PERIPHERAL

- a. Provide remote power supply(ies) as required for proper system operation.
- b. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds and other supervisory functions.
- c. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.
- d. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.
- e. Provide dedicated 120 volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

K. INSTALLATION

- (1) Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be in a completely separate conduit system from power wiring or other raceway systems. Minimum conduit size shall be 3/4" trade size. Maximum wire fill shall be 40%, for any raceway system.

All junction boxes shall have coverplates painted red and labeled "Fire Alarm". A consistent wiring color code shall be maintained throughout the installation. The number of wiring splices shall be minimized throughout. Excessive wire splicing (as determined by the Engineer), shall be cause for rejection of the work.

- (2) Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate tradesmen or other contractors.
- (3) The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

- (4) The manufacturer's authorized representative shall provide on-site supervision of installation, and shall perform the initial "power-up" of the system after he has thoroughly checked the installation.
- (5) Operation and maintenance manuals submitted for this project shall list names, license numbers, and telephone numbers of at least two installers that are employed full time by the supplier/manufacturer to install and test fire alarm systems in the installation location.

A floor plan drawing indicating fire alarm devices and wiring only, shall be provided by the manufacturing company for job site use. These drawings shall be approved by the State Fire Marshal's Office or Local Authority Having Jurisdiction, as appropriate and in accord with code requirements. A copy of this drawing shall be submitted to the Engineer for his review, approval and project records.

L. TESTING

- (1) The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the Contractor shall certify the test results in writing to the Fire Marshal, Owner, General Contractor, Architect and Engineer. Provide one week's written advance notice of the test to all concerned parties.
- (2) All auxiliary devices the fire alarm system is connected to, including tamper switches, flow switches, elevator controls, remote receiving stations, etc., shall be fully tested for proper operation where interfacing with the fire alarm system.
- (3) The Contractor shall provide a minimum of three hours of instructional time to the Owner in the operation and maintenance of all equipment and components. A receipt shall be obtained from the Owner that this has been accomplished, and a copy forwarded to the Engineer. Provide additional training time if required by the Owner at no charge to the contract or as direct charge to the Owner.

M. WARRANTY

- (1) The Contractor shall unconditionally guarantee (except for vandalism or misuse) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one year from the date of substantial completion.
- (2) The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H guidelines.

END OF SECTION 283100

SECTION 311000 – SITE CLEARING

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. Protecting existing trees and grass to remain.
 - 2. Removing existing trees, shrubs, groundcovers plants and grass.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping or sealing and removal of storm drainage utilities.
 - 7. Temporary erosion and sedimentation control measures.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
 - 2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
 - 3. Division 01 Section "Execution" for verifying utility locations and for recording field measurements.
 - 4. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
 - 5. Division 23 Section "Turf and Grasses and Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.
 - 6. Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 Sections for removal of site utilities except storm sewers.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.
- C. Storm Water Pollution Prevention Plan: Submit prior to beginning construction and maintain on-site, and available for regular review by the Architect the following:
 - 1. Copy of the Notice of Intent (NOI).
 - 2. Copy of the Site Grading Permit.
 - 3. Copy of the SWPP along with related written documents.
 - 4. Maintenance Log Book in conformance with the requirements indicated.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and the Storm Water Pollution Prevention Drawings (SWPP).
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.
- 3.4 UTILITIES
- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Removal of underground utilities is included in Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 Sections covering site utilities.
- 3.5 CLEARING AND GRUBBING
- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 4. Use only hand methods for grubbing within tree protection zone.
 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within tree protection zones.
 - 3. Dispose of excess topsoil as specified for waste material disposal.
 - 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

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. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling for storm drainage and subdrainage utility trenches.
8. Excavating and backfilling pits for buried storm drainage and subdrainage utility structures.

- B. Related Sections include the following:

1. Division 01 Section "Structural Special Inspections" for testing and inspections associated with all earthwork specified in this section.
2. Division 01 Section "Allowances" for quantity allowance provisions related to unit-price rock excavation and authorized additional excavation.
3. Division 01 Section "Unit Prices" for unit-price rock excavation and authorized additional excavation provisions.
4. Division 01 Section "Construction Progress Documentation and Photographic Documentation" for recording preexcavation and earthwork progress.
5. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
6. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
7. Divisions 21, 22, 23, 26, 27, and 28 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
8. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
9. Division 31 Section "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
10. Division 32 Section "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
11. Division 32 Section "Plants" for planting bed establishment and tree and shrub pit excavation and planting.
12. Division 33 Section "Subdrainage" for drainage of foundations and walls.

1.3 UNIT PRICES

- A. Unit prices for earthwork are included in Division 01 Section "Unit Prices."
- B. Rules of Measurement: Volume of material actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.
 - 1. 24 inches outside of concrete forms other than at footings.
 - 2. 12 inches outside of concrete forms at footings.
 - 3. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - 5. 6 inches beneath bottom of concrete slabs-on-grade.
 - 6. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.

- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Geotextile.
 - 3. Controlled low-strength material, including design mixture.
- B. Samples: 12-by-12-inch Sample of subdrainage and separation geotextile.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.
- D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.6 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.
 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Architect will not be responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 2. The geotechnical report is included elsewhere in the Project Manual.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups CL, GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
1. Subject to meeting project requirements, existing on-site excavated soils may be utilized as fill material.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Dense Graded Aggregate consisting of a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; KYDOH Section 805; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Dense Graded Aggregate consisting of a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; KYDOH Section 805; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Dense Graded Aggregate consisting of a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; KYDOH Section 805; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; KYDOH Section 805; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with KYDOH Section 843 for Type II Fabric.
- B. Separation / Reinforcement Geotextile:
 - 1. Type 1: Tensar Biaxial Geogrid BX1200 or approved equal product.
 - 2. Type 2: Tensar Biaxial Geogrid BX1100 or approved equal product.

2.3 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
 - C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.
 - D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.
- 3.2 DEWATERING
- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
 - B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
- 3.3 EXPLOSIVES
- A. Explosives: Do not use explosives.
- 3.4 EXCAVATION, GENERAL
- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Unless otherwise indicated, remove rock and other unsuitable material to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs on grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings, Foundations, Retaining Walls or Within 10 Feet of Building Elements: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. Refer to Drawings for additional requirements.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
- B. Below, drives and parking areas, where "old building fill", previous building construction (foundations, floor slabs or pavements), utility trenches, wet soils, soft soils, highly plastic clays with a PI of 30 or greater or other unsatisfactory soil is exposed at or within 2 feet of subgrade elevations, undercut the soil within and to a point 2 feet beyond the pavement edge. Replace the undercut soil areas with approved satisfactory lean silty clay or approved fill soils.
- C. Where pavement subgrades are bearing on rock, overexcavate to a depth of 4 inches and backfill to subgrade elevations with compacted #57 Drainage Fill.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit unless otherwise indicated.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

- A. Notify Architect and Geotechnical Testing Agency when excavations have reached required subgrade.
- B. If Architect in consultation with the Geotechnical Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
- D. Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.
 - 6. Under parking and driveway pavement use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Unless otherwise indicated, compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 100 percent.
 2. Under parking and driveway pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
 3. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.
 4. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 5. For storm and subdrainage trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."

- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
1. Place base course material over subbase course under hot-mix asphalt pavement.
 2. Shape subbase and base course to required crown elevations and cross-slope grades.
 3. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
 4. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 5. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage and pay for a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test with a Dynamic Cone Penetrometer (DCP) of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained at no additional cost.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property. Provide written documentation of disposal location(s) for all material hauled off site.

END OF SECTION 312000

SECTION 321216 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Cold milling of existing hot-mix asphalt pavement.
- 2. Hot-mix asphalt patching.
- 3. Hot-mix asphalt paving.
- 4. Hot-mix asphalt paving overlay.
- 5. Pavement-marking paint.

B. Related Sections:

- 1. Division 2 Section "Site Clearing" for demolition, removal, and recycling of existing asphalt pavements.
- 2. Division 2 Section "Earthwork" for aggregate subbase and base courses.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

- 1. Job-Mix Designs: For each job mix proposed for the Work.

- B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

- C. Samples: For each paving fabric, 12 by 12 inches minimum.

- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

- 1. Each paving fabric, 12 by 12 inches minimum.
- 2. Each type and color of preformed traffic-calming device.
- 3. Each pattern and color of precut marking material.

- E. Qualification Data: For qualified manufacturer and Installer.

- F. Material Certificates: For each paving material, from manufacturer.
- G. Material Test Reports: For each paving material.

1.5 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.
 - 1. Standard Specification: Kentucky Department of Highways (KYDOH), "Standard Specification for Road and Bridge Construction", current edition.
 - 2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

- 1.9 Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: KYDOH Section 805, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.
- C. Fine Aggregate: KYDOH Section 804, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.
- D. Mineral Filler: KYDOH Section 804, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: KYDOH Section 806.
- B. Asphalt Cement: KYDOH Section 806.
- C. Prime Coat: KYDOH Section 806.
- D. Tack Coat: KYDOH Section 806, emulsified asphalt of suitable grade and consistency for application.
- E. Water: Potable.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.
 - 1. Color: White and blue, as indicated.
- C. Thermoplastic Markings: Comply with KYDOH Section 717.
- D. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches high by 6 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 2. Provide the maximum allowable recycled asphalt content as permitted by the KYDOH Standard Specifications for the applicable mix.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
1. Mill to a depth of 1-1/2 inches.
 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 3. Control rate of milling to prevent tearing of existing asphalt course.
 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 6. Transport milled hot-mix asphalt to asphalt recycling facility.
 7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: The Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

SECTION 321313 – CONCRETE PAVING

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 exterior cement concrete pavement for the following:
 - 1. Service area pavements.
 - 2. Curbs.
 - 3. Walkways.
 - 4. Unit paver base.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
 - 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Qualification Data: For manufacturer and testing agency.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
- E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

F. Field quality-control test reports.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Obtain Architect's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Demolish and remove approved mockups from the site when directed by Architect.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

- a. Contractor's superintendent.
- b. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- C. Plain Steel Wire: ASTM A 82, galvanized.
- D. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- E. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- F. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.

- B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- C. Water: ASTM C 94/C 94M.

- D. Air-Entraining Admixture: ASTM C 260.

- E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

- C. Water: Potable.

- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Available Products:

- a. Axim Concrete Technologies; Cimfilm.
- b. Burke by Edeco; BurkeFilm.
- c. ChemMasters; Spray-Film.
- d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
- e. Dayton Superior Corporation; Sure Film.
- f. Euclid Chemical Company (The); Eucobar.
- g. Kaufman Products, Inc.; Vapor Aid.
- h. Lambert Corporation; Lambco Skin.
- i. L&M Construction Chemicals, Inc.; E-Con.
- j. MBT Protection and Repair, ChemRex Inc.; Confilm.
- k. Meadows, W. R., Inc.; Sealtight Evapre.
- l. Metalcrete Industries; Waterhold.
- m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
- n. Sika Corporation, Inc.; SikaFilm.
- o. Symons Corporation; Finishing Aid.
- p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Available Products:

- a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
- b. Burke by Edoko; Aqua Resin Cure.
- c. ChemMasters; Safe-Cure Clear.
- d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
- e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
- f. Euclid Chemical Company (The); Kurez DR VOX.
- g. Kaufman Products, Inc.; Thinfilm 420.
- h. Lambert Corporation; Aqua Kure-Clear.
- i. L&M Construction Chemicals, Inc.; L&M Cure R.
- j. Meadows, W. R., Inc.; 1100 Clear.
- k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
- l. Symons Corporation; Resi-Chem Clear.
- m. Tamms Industries Inc.; Horncure WB 30.
- n. Unitex; Hydro Cure 309.
- o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
 - 1. If an asphaltic fiber joint filler is utilized, provide an acceptable polyethylene bond breaker tape where joint sealant is indicated.
- B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

- C. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
1. Available Products:
 - a. Burke by Edeco; True Etch Surface Retarder.
 - b. ChemMasters; Exposee.
 - c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
 - d. Euclid Chemical Company (The); Surface Retarder S.
 - e. Kaufman Products, Inc.; Expose.
 - f. Metalcrete Industries; Surfard.
 - g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
 - h. Scofield, L. M. Company; Lithotex.
 - i. Sika Corporation, Inc.; Rugasol-S.
 - j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.7 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use high-range, high-range, water-reducing and retarding admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
1. Fly Ash or Pozzolan: 15 percent.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
 - 3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."
- C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

2. Sawn Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.
- J. Screed pavement surfaces with a straightedge and strike off.
- K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

- L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
1. Elevation: 1/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
 8. Joint Spacing: 3 inches.
 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage and pay for a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 3.11 REPAIRS AND PROTECTION
- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
 - B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
 - C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 – CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
 - 2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the Notice to Proceed with the Work.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent Jet-Fuel-Resistant Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C 920 for type, grade, class, and uses indicated:
1. Urethane Formulation: Type M; Grade P; Class 12-1/2; Uses T, M, and, as applicable to joint substrates indicated, O.
 - a. Available Products:
 - 1) Pecora Corporation; Urexpan, Dynatred.
 - 2) Sonneborn, Div. of ChemRex, Inc.; Sonolastic SL 2.
- B. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
1. Available Products:
 - a. Sonneborn, Div. of ChemRex, Inc.; Sonolastic SL 1.
 - b. Tremco Sealant/Waterproofing Division; Vulkem 45SSL.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.

2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
 - G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

END OF SECTION 321373

SECTION 321400 - UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Concrete pavers set in aggregate setting beds on concrete base.
 - 2. ADA Warning Tiles
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for excavation and compacted subgrade.
 - 2. Division 2 Section "Cement Concrete Pavement" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraint for unit pavers.
 - 3. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit pavers with elastomeric sealants.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Pavers.
- B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- C. Samples for Initial Selection: For the following:
 - 1. Each type of unit paver indicated.
- D. Samples for Verification:
 - 1. Full-size units of each type of unit paver indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
 - B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- 1.6 PROJECT CONDITIONS
- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

- A. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates. Subject to compliance with requirements, provide Paverlock, "Oxford Non-tumbled" pavers.
 1. Basis-of-Design Product: The design for concrete pavers is based on Paverlock, "Oxford Non-tumbled" pavers.. Subject to compliance with requirements, other manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nitterhouse 'Interlocking Paver' in Sandstone Blend- squares
 - b. Pavestone 'City Stone' in Edgington Blend – squares
 2. Thickness: 2-3/8 inches
 3. Face Size and Shape: 5-1/2 inches x 5-1/2 inches square.
 4. Color: Hampton Green Blend. Final color selection to be by Architect from Manufacturer's full range.
- B. ADA Warning Tiles provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (title 49 cfr transportation, part 37.9 standards for accessible transportation facilities, Appendix A, Section 4.29.2 detectable warnings on walking surfaces.
 1. Detectable Warnings: Tiles shall comply fully with the current provisions for Detectable Warnings of the Americans with Disabilities Act.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armor Tile Detectable Warning Tile, case in place

- b. ADA Solutions Cast in Place Tactile Warning Surface Tiles
 - c. Alertcast Detectable Warning Tile, cast in place
- 3. Thickness: 2-inches.
 - 4. Face Size and Shape: As indicated on drawings.
 - 5. Color: As selected by Architect from manufacturer's full range.
 - 6. Installation: Embed tile in concrete per manufacturer's written specifications.

2.2 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Division 2 Section "Earthwork" for base course.
- B. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.
- C. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
 - 1. Provide sand of color needed to produce required joint color.
- D. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 - 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 - 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- E. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

- C. Proof-roll prepared subgrade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. Exercise care in handling coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. Remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: As indicated.
- F. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- G. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.

3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place drainage geotextile over concrete subbase, overlapping ends and edges at least 12 inches.
 - 1. Verify that drain holes have been provided in concrete subbase. If not, do not proceed until the condition has been corrected.
- D. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- E. Treat leveling course with herbicide to inhibit growth of grass and weeds.

- F. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
- G. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
 2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover pavers that have not been compacted, and leveling course on which pavers have not been placed, with nonstaining plastic sheets to protect them from rain.
- H. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- I. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- J. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 321400

SECTION 321443 - POROUS UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Porous paving consisting of concrete pavers set in aggregate setting beds.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for excavation and compacted subgrade.
 - 2. Division 2 Section "Cement Concrete Pavement" for cast-in-place concrete curbs that serve as edge restraints for porous paving.
 - 3. Division 2 Section "Unit Pavers" for nonporous unit paving, and edge restraints.

1.3 SUBMITTALS

- A. Product Data: For materials other than aggregates.
- B. Product Data: For the following:
 - 1. Pavers.
 - 2. Geotextiles.
- C. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- D. Samples for Initial Selection:
 - 1. Each type of unit paver indicated.
 - 2. Aggregate fill.
- E. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 - 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of porous paver from one source that has resources to provide materials and products of consistent quality in appearance and physical properties.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

PART 2 - PRODUCTS

2.1 CONCRETE UNIT PAVERS

- A. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, and made from normal-weight aggregates.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide "Hydra-bric" manufactured by Paverlock Corporation or one of the following products:
 - a. Nitterhouse 'Aquapave'
 - b. Unilock 'Eco Prioria'
 - 2. Thickness: 3.125 inches.
 - 3. Face Size and Shape: 3.88 inches x 8 inches.
 - 4. Color: As selected by Architect from manufacturer's full range.
 - 5. Unit pavers / porous unit paving system must comply with ADA / ADAAG requirements and tolerances for accessible pavements.
 - 6. Pattern as indicated on drawings, with soldier edge course continuous around pavers.

2.2 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Base Course: Requirements in Division 2 Section "Earthwork" for base material. Base material shall be roof top stone, which shall be #57's as provided as part of roofing / Alternate No. 1 scope.
- B. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 10.
- C. Graded Aggregate for Porous Paver Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 11.

- D. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive base course for porous paving.

3.2 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- C. Tolerances:
1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.
 2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.
- D. Verify that curbs provided under Division 2 Section "Cement Concrete Paving" are in-place before placing unit pavers.

3.3 SETTING-BED INSTALLATION

- A. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- B. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.4 PAVER INSTALLATION

- A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If

pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- minimum and 1/8-inch- maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
- B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
 2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- C. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
1. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch width of unfilled paving adjacent to temporary edges (laying faces).
 2. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches of laying face.
 3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
- D. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 321443

SECTION 323119 - ORNAMENTAL METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Decorative metallic-coated steel wire fences.
- 2. Swing gates.

B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for concrete post concrete fill.
- 2. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where decorative metal fences and gates are located.

1.3 SUBMITTALS

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

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

- C. Samples: For each fence material and for each color specified.

- 1. Provide Samples 12 inches in length for linear materials.
- 2. Provide Samples 12 inches square for wire mesh materials.

- D. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- C. Mockups: Build mockups to set quality standards for fabrication and installation.

- 1. Include 10-foot length of fence complying with requirements.
- 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- D. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Tubing: ASTM A 500, cold formed steel tubing.
- C. Castings: Either gray or malleable iron unless otherwise indicated.
1. Gray Iron: ASTM A 48/A 48M, Class 30.
 2. Malleable Iron: ASTM A 47/A 47M.

2.2 COATING MATERIALS

- A. Epoxy Primer for Galvanized Steel: Complying with MPI #101 and compatible with coating specified to be applied over it.
1. Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
1. Use product with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
1. Use product with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

2.4 DECORATIVE METALLIC-COATED STEEL WIRE FENCES

- A. Decorative Metallic-Coated Steel Wire Fences:

1. Basis of Design Product: Ameristar Fence "Wireworks Plus" architectural welded wire fence. Or equivalent product from one of the following manufacturers:
 - a. Ametco Manufacturing Corporation.
 - b. Master Halco.
 - c. Metalco Omega Fence.
 - B. Metallic-Coated Steel Wire: Welded-wire fence fabric, hot-dip galvanized after fabrication. Weight of zinc coating shall be not less than 1.0 oz./sq. ft..
 1. Spacing of Vertical Wires: 2 inches.
 2. Vertical Wire Size: 0.192 inch.
 3. Spacing of Horizontal Wires: 4 inches.
 4. Horizontal Wire Size: 0.192 inch.
 - C. Posts:
 1. Line Posts: Square tubes 2 by 2 inches formed from 0.079-inch nominal-thickness, metallic-coated steel sheet or formed from 0.075-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
 2. End and Corner Posts: Square tubes 3 by 3 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
 - D. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.
 - E. Rails: Square tubes.
 1. Size: 1-3/8 by 1-1/2 inches or 1-1/2 by 1-1/2 inches.
 2. Metal and Thickness: 0.079-inch nominal-thickness, metallic-coated steel sheet or 0.075-inch nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.
 - F. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers or clips.
 - G. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
 - H. Finish: Powder coating.
- 2.5 SWING GATES
- A. Gate Configuration: As indicated.
 - B. Gate Frame Height: As indicated.
 - C. Gate Opening Width: As indicated.
 - D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes 2 by 2 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.

- E. Frame Corner Construction: Welded or assembled with corner fittings and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.
- F. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- G. Infill: Comply with requirements for adjacent fence.
- H. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
- I. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
 - 1. Function: 320 - Gate spring pivot hinge. Adjustable tension.
 - 2. Material: Malleable iron.
- J. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in closed position.
- K. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
- L. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- M. Steel Finish: Manufacturer's factory finish.

2.6 STEEL FINISHES

- A. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- B. Powder Coating: Immediately after cleaning, apply 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.
- C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.
- D. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
 - 1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Division 01 Section "Execution"

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323119

SECTION 329200 – TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Seeding.
- 2. Sodding.
- 3. Lawn renovation.
- 4. Erosion-control material(s).

B. Related Sections:

- 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
- 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.
- D. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.

- C. Qualification Data: For qualified landscape Installer.
- D. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- E. Material Test Reports: For existing surface soil.
- F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn and meadow establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
 - 2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil. Topsoil shall be tested immediately after stockpiling to verify quality of available topsoil and amendments required.
 - 1. Report suitability of topsoil for lawn growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1st – April 30th.
 - 2. Fall Planting: September 1st – October 15th.

- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 MAINTENANCE SERVICE

- A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Full lawn maintenance as required in Part 3.10 below. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

- 1. Seeded Lawns: 60 days past date of Project Substantial Completion.

- a. When initial maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

- B. Sodded Lawns: 60 days past date of Project Substantial Completion.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

- B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

- 1. Sun and Partial Shade: Proportioned by weight as follows:

- a. 85 percent blend three species of Turf Type Tall Fescues.
- b. 15 percent Kentucky Bluegrass (*Poa pratensis*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

- 1. Full Sun: Blend of three "fine blade turf type" Tall Fescue cultivars acceptable to the Architect.

2.3 PLUGS

- A. Gro-plug plant mix:

- 1. Install equal parts within plant mix @ 24" O.C. (typ)
- 2. Plug Size: 2 inches

2.4 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 2 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.5 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2.6 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.7 FERTILIZER

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.8 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Detention Area : Natural dye-free shredded hardwood bark mulch. Provide air-dry clean, mildew and seed free mulch with a minimum of 2" thick within Detention Areas that receive gro-plugs.

2.9 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

2.10 PLANTING SOIL MIX

- A. Planting Soil Mix: Topsoil mixed with the following soil amendments and fertilizers in the following quantities:
 - 1. Weight of Lime per 1000 Sq. Ft.: As determined by Soil Test.
 - 2. Weight of Sulfur per 1000 Sq. Ft.: As determined by Soil Test..
 - 3. Weight of Commercial Fertilizer per 1000 Sq. Ft.: As determined by Soil Test.
- B. Detention Area Soil: 10" of manufactured soil mix. 1:1 soil mix comprised of 50% loamy soil and 50% organic matter with a soil PH of 6.5 - 7.5. Bulk density must be between 1.05 – 1.17 G/CC.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect grade stakes set by others until directed to remove them.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

- a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 2. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
 - C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply fertilizer directly to surface soil before loosening.
 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
 - D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
 - E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
 - F. Before planting, restore areas if eroded or otherwise disturbed after finish grading.
- 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS
- A. Prepare area as specified in "Lawn Preparation" Article.
 - B. For erosion-control blanket, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
 - C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow grass seed at a total rate of 7 to 8 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with erosion-control mats where shown, installed and anchored according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 PLUGGING

- A. Plant plugs in holes or furrows, spaced 24" apart in both directions. On slopes, contour furrows to near level.

3.8 LAWN RENOVATION

- A. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 - 1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
 - 2. Provide new topsoil as required.
- B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
- C. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- D. Mow, dethatch, core aerate, and rake existing lawn.
- E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- H. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- I. Apply seed and protect with straw mulch as required for new lawns.
- J. Water newly planted areas and keep moist until new lawn is established.

3.9 LAWN MAINTENANCE

- A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
- B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water lawn with fine spray at a minimum rate of 1 inch per week throughout Maintenance Period as defined in 1.8, unless rainfall precipitation is adequate.
- C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height throughout Maintenance Period as defined

in 1.8. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to a height of 2 to 3 inches.

D. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

3.10 SATISFACTORY LAWNS

A. Lawn installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities including any visible rocks or stone, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities including any visible rocks or stone.

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after lawn is established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 – PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Trees
- 2. Shrubs
- 3. Perennials
- 4. Groundcovers
- 5. Vines

B. Related Sections:

- 1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
- 2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
- 3. Division 32 Section "Turf and Grasses" for lawn.
- 4. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes indicated; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
- C. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

- G. Planting Soil: Native or imported topsoil, mixed with soil amendments.
- H. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- I. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each of the following:
 - 1. Edging materials and accessories, of manufacturer's standard size, to verify color selected.
- C. Qualification Data: For qualified landscape Installer.
- D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- E. Material Test Reports: For existing surface soil and imported topsoil.
- F. Planting Schedule: Indicating anticipated planting dates for exterior plants.
- G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for plant growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

- D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
 - 1. Selection of exterior plants purchased under allowances will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.
- E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
- F. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify Architect of sources of planting materials seven days in advance of delivery to site.
- G. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver exterior plants freshly dug.
 - 1. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.
- B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.
- C. Handle planting stock by root ball.
- D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 2. Do not remove container-grown stock from containers before time of planting.
 - 3. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1st to May 15th.

- 2. Fall Planting: October 15th to December 1st.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.
- C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.
 - 1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer's standard form in which Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty operation of tree stabilization and edgings.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Periods from Date of Substantial Completion:
 - a. Trees and Shrubs: One year.
 - b. Ground Cover and Plants: One year.
 - 3. Include the following remedial actions as a minimum:
 - a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
 - b. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees, Shrubs, Ground Cover and Plants: Provide full maintenance by skilled employees of landscape installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than 60 days past the date of Project Substantial Completion.

PART 2 - PRODUCTS**2.1 TREE AND SHRUB MATERIAL**

- A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.
- E. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

- A. Type 1 or Type 2 (Slower Growth) Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
 - 1. Provide balled and burlapped trees.
 - 2. Branching Height: One-half of tree height.
- B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk or multi-trunk clump as indicated.
 - 2. Provide balled and burlapped trees.
- C. Small Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk or multi-stem clump as indicated.
 - 2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
 - 1. Shrub sizes indicated are sizes after pruning.
 - 2. Provide balled and burlapped or container-grown shrubs as indicated.
 - 3. Provide balled and burlapped trees.

2.4 GROUND COVER PLANTS

- A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1 and the following requirements:

2.5 PLANTS

- A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

2.6 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. Stones shall not exceed 10% by volume.
 - 1. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.7 INORGANIC SOIL AMENDMENTS

- A. Aluminum Sulfate: Commercial grade, unadulterated.

2.8 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- C. Manure: Well-rotted, composted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.9 FERTILIZER

- A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.10 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded pine bark.

2.11 TREE STABILIZATION MATERIALS

- A. Stakes and Guys:
 - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 - 2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or compression springs.

2.12 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch- wide minimum, with stretch factor of 33 percent.

2.13 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:
 - 1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
 - 2. Ratio of Loose Peat to Topsoil by Volume: 1:4.
 - 3. Weight of Aluminum Sulfate per 1000 Sq. Ft.: As recommended by soil test.
 - 4. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: As recommended by soil test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before planting. Make minor adjustments as required.
- D. Lay out exterior plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
- E. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.
- F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING BED ESTABLISHMENT

- A. Loosen subgrade of planting beds to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 2. Spread planting soil mix to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
- B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, restore planting beds if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
 - 1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
- B. Subsoil removed from excavations may not be used as backfill.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
 - 1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
 - 1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- C. Set container-grown stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
 - 1. Carefully remove root ball from container without damaging root ball or plant.
 - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- D. Organic Mulching: Apply 2-inch minimum thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.
- E. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character.

3.7 TREE STABILIZATION

- A. Trunk Stabilization: Unless otherwise indicated, provide trunk stabilization as follows:
 - 1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend dimension shown above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 - 2. Use 2 stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; 3 stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
 - 3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants as indicated.
- B. Dig holes large enough to allow spreading of roots and backfill with planting soil.
- C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING BED MULCHING

- A. Mulch backfilled surfaces of planting beds and other areas indicated. Provide mulch ring around trees in lawn areas.
 - 1. Organic Mulch: Apply 2-inch minimum thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.10 EDGING INSTALLATION

- A. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 36 inches apart, driven below top elevation of edging.

3.11 PLANT MAINTENANCE

- A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.
- B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

3.12 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.13 DISPOSAL

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Nonpressure transition couplings.
 - 3. Cleanouts.
 - 4. Drains.
 - 5. Manholes.
 - 6. Stormwater inlets
 - 7. Junction boxes
 - 8. Pipe outlets.
 - 9. Downspout boot with integral cleanout

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 - 2. Terrace drains, stormwater inlets, junction boxes, pipe outlets and cleanouts. Include plans, elevations, sections, details, frames, covers, and grates.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic drainage structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle stormwater inlets according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS**2.1 PE PIPE AND FITTINGS**

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
 - 1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets
 - 2. Class III, Wall B.

2.3 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Concrete Pipes: ASTM C 443, rubber.
 - 2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 3. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 4. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 5. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Mfg.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

2. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, polished bronze cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
4. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 STORMWATER INLETS

A. Catch Basin: Precast or cast-in-place basin and heavy duty grate and frame, size as indicated.

B. Yard Inlet: Nyloplast "Drain Basin", size as indicated with heavy duty cast iron grate and frame or approved similar product.

2.8 PIPE OUTLETS

A. Head Walls: KYDOH Sloped and Flared, size as indicated with precast or cast-in-place basin conforming with KYDOH Standard Drawing or RDH-020-03.

B. Turf Reinforcement Basin: Dense web of interlocking multi-lobed polypropylene threads, chemical and UV stabilized against degradation, with no bio-degradable components.

2.9 DOWNSPOUT BOOT WITH INTEGRAL CLEANOUT

Downspout Boot with Integral Cleanout: Cast iron for 6x6 (or other size as indicated on Drawings) angular downspout, with factory powdercoat finish in color to be selected by Architect. Downspout boot to have integral cleanout. Rubber adapter as needed to provide transition from downspout boot to storm pipe. Basis of Design J.R. Hoe and Sons, Inc. A series angular downspout boot or equivalent.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping with minimum cover as indicated.
 - 3. Install PE corrugated sewer piping according to ASTM D 2321.
 - 4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use Heavy-Duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 12 by 12 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
 1. Use Heavy-Duty, top-loading classification drains in all areas.
- B. Embed drains in 4-inch minimum concrete around bottom and sides.
- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.

3.6 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 1 inch above finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.8 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlets, head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Set frames and grates to elevations indicated.
- C. Place turf reinforcement mat as indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

3.9 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.10 IDENTIFICATION

- A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.12 CLEANING
- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

SECTION 334600 - SUBDRAINAGE

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 subdrainage systems for the following:
 - 1. Landscaped areas.
 - 2. Retaining walls.
- B. Related Sections include the following:

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.
- E. PS: Polystyrene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Perforated-wall pipe and fittings.
 - 2. Solid-wall pipe and fittings.
 - 3. Drainage conduits.
 - 4. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.3 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
 - 1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 - 2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 - 3. Couplings: Manufacturer's standard, band type.

2.4 SOLID-WALL PIPES AND FITTINGS

- A. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.
 - 1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.

2.5 SPECIAL PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
 - 1. Sleeve Materials:
 - a. For Concrete Pipes: ASTM C 443, rubber.

- b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - c. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - d. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
2. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

2.7 SOIL MATERIALS

- A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.8 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
 - 1. Structure Type: Nonwoven, needle-punched continuous filament.
 - 2. Style(s): Flat and/or sock style as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

A. Underground Subdrainage Piping:

1. Perforated PE pipe and fittings, couplings, and coupled joints.

3.4 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth: Cast-iron cleanouts.
2. At Grade in Paved Areas: Cast-iron cleanouts with brass cover and plug.

3.5 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade unless otherwise indicated.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.6 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 2. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 3. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 4. Lay perforated pipe with perforations down.
 5. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install PE piping according to ASTM D 2321.

3.7 PIPE JOINT CONSTRUCTION

- A. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.8 CLEANOUT INSTALLATION

- A. Cleanouts for Landscaping Subdrainage:
1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
 3. In nonvehicular-traffic areas, use NPS 4 cast-iron pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.10 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping.
 - 1. Install PE warning tape or detectable warning tape over ferrous piping.
 - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.12 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600