FOR THE PROJECT TITLED:

TENNESSEE SCHOOL FOR THE DEAF

NEW HIGH SCHOOL AND INFRASTRUCTURE UPGRADES

KNOXVILLE, TENNESSEE

DATE: SEPTEMBER 14, 2015
SBC NUMBER: 168/007-01-2013
PROJECT NUMBER: LGA 14042

OWNER:

TENNESSEE SCHOOL FOR THE DEAF

CONSTRUCTION MANAGER:

RENTENBACH CONSTRUCTORS, INC.

ARCHITECT:

THE LEWIS GROUP ARCHITECTS, INC., P.C.

CONSULTANTS:

ARCHITECTURAL CONSULTANT	HANSEL BAUMAN ARCHITECT + PLANNER
CIVIL ENGINEERING	FULGHUM MACINDOE & ASSOCIATES, INC.
STRUCTURAL ENGINEER	PWP STRUCTURAL ENGINEERS
FIRE PROTECTION/PLUMBING/ MECHANICAL ENGINEERING -	ENGINEERING SERVICES GROUP, INC.
ELECTRICAL ENGINEERING	VREELAND ENGINEERS, INC.
FOOD SERVICE	ANN DELAP

SET NO.

SECTION 00 01 10 – TABLE OF CONTENTS

VOLUME 1

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 01 07 Seals Page
00 01 10 Table of Contents
00 01 15 List of Contract Drawings
00 11 16 Invitation to Bid
00 21 13 Instructions to Bidders
00 30 00 Information Available to Bidders
00 31 32 Geotechnical Data
00 38 60 Disqualified Contractors and Subcontractors
00 38 60.10 List of Qualified Bidders
00 40 00 Work Categories for Bidders
00 41 13 Bid Form
00 52 01.10 Agreement Forms
00 52 23 Construction Services Agreement Between Owner and Construction Manager / General Contractor
00 52 23.10 Subcontract Agreement
00 54 33 Authorization Agreement for Automatic Deposits (ACH Credits) Form
00 54 35 Substitute W-9 Form
00 54 43 Retainage Escrow Initiation
00 55 00 Subcontractor Insurance Requirements
00 61 13 Contract Bond
00 61 43 Three Year Roof Bond
00 65 01 Non-Use of Asbestos Containing Materials Affidavit – Contractor
00 72 23 General Conditions of the Contract Construction – AIA Document A201-1997
00 73 15 Supplementary Conditions
00 80 00 Project Safety Plan

DIVISION 01 - GENERAL REQUIREMENTS

01 21 13 Allowances
01 22 19 Unit Prices
01 23 00 Alternates
01 26 00 Modification Procedures
01 26 10 CM/GC - GMP Contingency and Owner Reserve Procedures
01 26 20 Weather Delays
01 26 39 Form for Field Order
01 26 40 Form for Amendment, Change Order, or Directive
01 26 50 Forms for Contractor's or Subcontractor's Cost Itemization
01 29 73 Schedules of Values
01 29 76 Payment Procedures
01 29 76.13 Personnel Used in Contract Performance
01 31 13.23 Design Coordination / Building Information Modeling
01 31 13.91 Commissioning Coordination
01 31 19 Project Meetings
01 31 90 Administrative Logs
01 32 00 Construction Schedule
01 32 15 Progress Schedules and Reports
01 33 00 Submittal Procedures
01 33 91 Commissioning Submittals
01 35 13.22 Special Schools' Project Procedures
01 40 00 Quality Requirements
01 41 15 Regulatory Requirements

01 42 00 References
01 43 25 Testing Laboratory Services
01 50 00 Temporary Facilities and Controls
01 62 25 Product Options and Substitutions
01 62 32 Substitution Request Form
01 73 29 Cutting and Patching
01 74 00 Cleaning and Waste Management
01 74 19 Construction Waste Management
01 77 70 Contract Closeout
01 77 70.91 Contract Commissioning Closeout
01 78 21 Closeout Submittals
01 78 26 Form for Roof Data
01 78 36 Roofing System Warranty
01 78 88 Report of Subcontractors and Suppliers
01 79 00 Demonstration and Training
01 81 13 Sustainable Design Requirements
01 91 13 General Commissioning Requirements

DIVISION 02 - EXISTING CONDITIONS
02 41 19 Selective Demolition

DIVISION 03 - CONCRETE
03 15 13 PVC Waterstop
03 30 00 Cast in Place Concrete

DIVISION 04- MASONRY
04 20 00 Unit Masonry
04 42 00 Exterior Stone Cladding

DIVISION 05 - METALS
05 12 00 Structural Steel Framing
05 21 00 Steel Joist Framing
05 31 00 Steel Decking
05 40 00 Cold-Formed Metal Framing
05 44 00 Cold-Formed Metal Trusses
05 50 00 Metal Fabrications
05 51 00 Steel Stairs
05 52 13 Pipe and Tube Railings
05 73 00 Decorative Metal Railing

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES
06 10 53 Miscellaneous Rough Carpentry
06 16 00 Sheathing
06 18 13 Glued Laminated Beams
06 40 23 Interior Architectural Woodwork
06 61 16 Solid Surface Fabrications

DIVISION 07 - THERMAL AND MOISTURE PROTECTION
07 11 13 Bituminous Dampproofing
07 13 26 Sheet Waterproofing
07 21 00 Thermal Insulation
07 22 00 Roof and Deck Insulation
07 25 00 Weather Barriers
07 26 16 Below Grade Vapor Retarders
07 31 13 Asphalt Shingles

07 41 10 Metal Wall Panels
07 41 13 Metal Roof Panels
07 42 16 Insulated Metal Wall Panels
07 53 23 Ethylene propylene Diene Monomer (EPDM) Roofing
07 62 00 Sheet Metal Flashing and Trim
07 71 00 Roof Specialties
07 72 33 Roof Hatches
07 84 13 Penetration Firestopping
07 84 56 Fire Safing
07 92 00 Joint Sealants

DIVISION 08 - OPENINGS
08 11 13 Hollow Metal Doors and Frames
08 14 16 Flush Wood Doors
08 31 00 Access Doors
08 33 23 Coiling Overhead Doors
08 34 93 Overhead Coiling Smoke Curtain
08 41 13 Aluminum Entrances and Storefronts
08 44 13 Glazed Aluminum Curtain Walls
08 71 00 Door Hardware
08 80 00 Glazing
08 88 13 Fire Resistant Glazing

DIVISION 09 - FINISHES
09 22 00 Portland Cement Stucco
09 22 16 Non-Structural Metal Framing
09 29 00 Gypsum Board
09 30 00 Tiling
09 51 13 Acoustical Panel Ceilings
09 65 00 Resilient Flooring and Accessories
09 67 16 Epoxy Terrazzo
09 67 23 Resinous Flooring
09 68 00 Carpeting
09 91 00 Painting

DIVISION 10 - SPECIALTIES
10 21 13 Toilet Compartments
10 22 26 Operable Partitions
10 28 13 Toilet Accessories
10 44 00 Fire Protection Specialties
10 51 13 Metal Lockers
10 82 13 Aluminum Roof Screens

DIVISION 11 - EQUIPMENT
11 13 19 Loading Dock Equipment
11 40 00 Food Service Equipment
11 53 13 Laboratory Fume Hoods

DIVISION 12 - FURNISHINGS
12 24 13 Roller Window Shades
12 35 53 Laboratory Casework

DIVISION 13 - SPECIAL CONSTRUCTION
Not Used

DIVISION 14 - CONVEYING EQUIPMENT

14 24 23 Hydraulic Passenger Elevator

VOLUME 2

DIVISION 21 - FIRE SUPPRESSION

21 05 00 Fire Protection and Sprinkler

DIVISION 22 – PLUMBING

22 05 00 General Provisions
22 05 10 Basic Materials and Methods
22 05 29 Supports and Anchors
22 07 00 Insulation
22 08 00 Commissioning of Plumbing Systems
22 10 00 Plumbing

DIVISION 23 - HVAC

23 05 00 Common Work for HVAC
23 05 10 Basic Materials and Methods
23 05 93 Testing, Adjusting and Balancing
23 07 00 Insulation
23 08 00 Commissioning of HVAC Systems
23 09 00 Controls and Instrumentation
23 09 10 Adjusting Frequency Variable Torque A/C Controller
23 21 13 HVAC Piping
23 21 15 Geothermal Closed-Loop Ground Heat Exchanger
23 21 23 Hydronic Pumps
23 23 00 Refrigerant Piping
23 30 00 Air Distribution
23 34 00 HVAC Fans
23 38 13 Kitchen Hood
23 52 16 Fire Tube Condensing Boilers
23 65 00 Cooling Tower
23 65 01 Chemical Treatment of Closed Circuit Cooler Spray Water
23 73 34 Weatherproof Indirect Fired Multi-Furnace Gas Make-Up Air Unit
23 74 13 100% Outside Air Package Roof Top Units
23 81 19 Package Roof Top Units
23 81 26.1 Ductless Split System
23 81 56 Heat Pumps

DIVISION 26 - ELECTRICAL

26 00 00 General Electrical
26 01 00 Equipment Identification
26 02 00 Supporting Devices
26 03 00 Power Service and Grounding
26 05 13 15 KV Conductors
26 05 19 Low Voltage, 600-VOLT Conductors
26 05 33 Raceways and Boxes
26 05 35 Wiring Devices
26 05 39 Floor Boxes
26 08 00 Commissioning of Electrical Systems
26 12 19 Three-Phase Padmounted Transformer

26 22 13 Dry Type Transformers
26 24 13 Switchboard (480-Volts)
26 24 16 Panelboards
26 28 16 Safety Switches
26 29 13 Manual Motor Starters
26 32 13 Natural Gas Generator Set
26 36 23 Automatic Transfer Switches
26 43 13 Surge Protection Devices
26 51 00 Lighting Fixtures
26 53 00 Exit Signs
26 54 00 Twin-Head Emergency Lighting Unit

DIVISION 27 - COMMUNICATIONS
27 00 00 General Communications
27 51 23 Integrated Intercom/Digital Telephone System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY
28 00 00 General Electronic Safety and Security
28 17 00 CCTY System
28 31 00 Fire Alarm System

DIVISION 31 – EARTHWORK
31 10 00 Site Clearing
31 20 00 Earthwork
31 23 33 Trenching and Backfilling
31 25 00 Erosion and Sedimentation Controls

DIVISION 32 – EXTERIOR IMPROVEMENTS
32 12 16 Asphalt Paving
32 13 13 Concrete Paving
32 16 00 Curbs and Gutters
32 17 23 Pavement Markings
32 32 23 Segmental Retaining Wall
32 92 19 Seeding

DIVISION 33 – UTILITIES
33 11 00 Water Utilities
33 12 16 Water Utility Distribution Valves
33 31 00 Sanitary Utility Sewerage Piping
33 40 00 Storm Drainage Utilities

END OF SECTION 00 01 10

SECTION 21 05 00 - FIRE PROTECTION AND SPRINKLER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to section 220500, General Provisions, which shall also govern sprinkler and fire protection work.

B. General Provisions of the Contract, General and Supplementary Conditions and General Requirements apply to this section.

1.2 DESCRIPTION OF WORK

A. A complete sprinkler system shall be furnished and installed to insure the lowest insurance rate possible; however, no requirements of NFPA 13, NFPA 24, Local Fire Marshal, State Fire Marshal, Division of Fire Prevention, or local water Department shall be violated and/or omitted.

B. **All areas indicated on plans shall be provided with an automatic sprinkler system in accordance with N.F.P.A. 13.**

C. **It shall be the Contractors responsibility to examine all architectural drawings, sections, details and structural drawings to determine areas required to be sprinklered to meet applicable code requirements.**

D. All cutting of holes necessary for the installation of work specified under this section of the specifications shall be done by this Contractor. Applicable provisions elsewhere in the specifications apply here, also. Cutting will be done under the supervision of the General Contractor. Do all patching of concrete, masonry and other materials which are cut by this Contractor, employing the services of the Contractor whose work is cut. Patching shall be of the same material and shall be finished neatly.

1.3 DRAWINGS

A. The drawings show and the specifications describe the work intended under this section, but the Contractor shall be solely responsible for taking his own measurements and installing the work to fit the conditions encountered everything necessary for a complete and satisfactory installation shall be furnished and installed by this Contractor performing work under this contract, whether or not specifically shown or specified. This is not intended to cover major items of equipment not shown or specified but is intended and will be interpreted to cover all miscellaneous parts, devices, accessories, controls, and appurtenances which are required by any applicable code, ordinance, regulation or law required to complete and place the system in satisfactory operation and required for a first class job which is complete in every respect.

B. The sprinkler system drawings are generally diagrammatic and are intended to show the location of areas to be sprinklered: locations and sizes of alarm valves and general locations and required sizes of outside piping, valves, etc. It shall be the responsibility of this Contractor to install all sprinkler work to coordinate with other trades in advance so as to clean all interferences with all architectural, structural, electrical, heating, ventilating, air conditioning, plumbing, sewerage, and other work. Any work installed by this Contractor which interferes with any other work by failure to coordinate said work shall be altered by this Contractor at his own expense as directed by the Architect to clear such interferences.

1.4 DEVIATIONS

A. No deviations from the plans and specifications shall be made without the full knowledge and consent of the Architect. Should this Contractor find at any time during the progress of the work that, in his judgement, existing conditions made desirable a modification in requirements covering any item he shall report such items to the Architect for his decision and instructions. No changes shall be made until written request has been made by the Contractor to the Architect and written approval of said change has been given by the Architect.

1.5 OMISSIONS

A. The drawings and specifications shall both be considered as part of the contract. Any work or material shown in one and omitted in the other shall be furnished and performed as though shown in both to give a complete sprinkler job approvable by the State Fire Marshall. The awarding of the contract shall be construed to mean that this Contractor will install a complete and satisfactory system, furnishing all items of materials and labor to accomplish this result whether or not such items are particularly specified or shown on plans. Should any discrepancy or omission be discovered in the plans or specifications, such must be reported to the Architect immediately in order that any necessary addenda may be issued before the bids are received.

1.6 INTERPRETATION

A. The meaning and intent of the plans and specifications shall be subject to the interpretations of the Architect whose decision on all questions pertaining thereto shall be binding upon the Contractor.

1.7 LOCAL STANDARDS

A. Term, "Local Standards", as used herein, means the standards of design and construction of respective municipal (or county) department or utility company.

1.8 COOPERATION

A. This Contractor shall visit the job site and thoroughly inform himself as to the conditions under which the work is to be done.

B. Failure to route pipes through the building without interfering with other Contractor's equipment or construction and at maximum possible elevation shall not constitute a reason for an extra charge.

C. All equipment requiring service shall be made easily accessible.

1.9 PERMITS, LICENSES AND INSURANCE

A. The Contractor shall obtain and pay for all permits, licenses, fees, etc., required for his work.

1.10 SHOP DRAWINGS

A. Submit shop drawings to architect. Obtain stamped approved plans and then submit approved drawings and to State Fire Marshall's Office for approval. No sprinkler work shall be done prior to all above approvals. Contractor shall include in his bid all equipment and labor necessary to comply with the Tennessee Department of Insurance requirements.

B. Submit 5 equipment submittals of all materials proposed for use in the work, giving name of manufacturer, trade name, catalog number and all information hereinafter requested. It is understood and agreed by all concerned that the Architect shall have the authority to reject any or all material, equipment or workmanship not complying with these specifications and that Contractor shall replace such rejected equipment, materials or workmanship upon notification by the Architect. Material or equipment rejected by the Architect shall be removed from the premises within twenty-four (24) hours after notification; otherwise, the Architect may have same removed at the Contractor's expense.

C. Submittal data and drawings shall be examined by the General Contractor prior to his transmitting to the above-mentioned authorities. The submittals shall bear the Contractor's stamp of approval evidencing that he has examined and checked same and that he found the information contained to be in accordance with the Contract requirements.

D. All materials and equipment furnished under this Section (15500) shall be new and approved by Underwriters' Laboratories, Inc. (UL), Factory Mutual (FM), or American Water Works Association (AWWA) where applicable.

1.11 GUARANTEE

A. The Contractor shall furnish a guarantee covering all labor and materials for a period of one year from date of acceptance of his work which shall include an agreement to repair replace and make good at his expense, any and all defects which may appear in his work or materials during that time, which in the judgement of the Architect arise from defective workmanship or imperfect or inferior materials.

PART 2 - PRODUCTS

2.1 PIPING

A. Pipe penetrating building floors, building walls, and pit walls shall be ductile iron, thickness Class 50, 350 psi pressure rating, in accordance with ANSI A21.51, tar coated outside, cement mortar lined inside in accordance with ANSI A21.4. Pipe shall be push-on mechanical joints on one end and flanged on the other.

B. Pipe and fittings, inside buildings: Schedule 40 black steel pipe for branch lines, and schedule 10 black steel pipe for sprinkler mains, conforming to ASTM A120 or A53, plain end, threaded end, or grooved end, as applicable to joint types involved; class 125 for pressure rating 175 psi black cast iron threaded fittings conforming to ANSI 816.4 or Schedule 40 black steel butt welding fittings conforming to ANSI 816.9 or Victaulic, Gustin-Bacon, or equal black malleable iron fitting, as applicable to joint types involved; fittings shall have at least 175 or 300 psi cold water working pressure ratings, and UL listing for fire protection service.

2.2 SLEEVES, FERRULES AND ESCUTCHEONS

A. The Contractor shall furnish and install pipe sleeves for all piping installed under this section. Sleeves shall be located at all wall partitions and floor penetrations.

B. All floor and exterior wall sleeves shall extend 1-1/2" above finished floor and beyond exterior wall surface. The void space between pipe and sleeve shall be caulked with an approved type waterproof caulking material.

C. Pipe sleeves through partitions and interior walls shall be exact thickness and terminate flush with wall or partition finish.

D. Pipe sleeves shall be steel of equal wall thickness of standard pipe the size in question.

E. Provide chromium-plated escutcheon plates for all exposed pipes projecting through floors or walls.

2.3 FLANGES AND VALVES

A. Flanges: 125 pound cast iron threaded, or 150 pound steel slip-on welding neck, or threaded, as applicable, conforming to ANSI 816.1 and 816.5 respectively; flanges for cast iron and ductile iron pipe shall be properly sized for this pipe, and shall have counterbored long hubs completely covering pipe threads; standard steel bolts and nuts; and plain rubber gaskets.

B. Valves, Interior: Check valves shall be equal to Crane No. 375 UL approved flanged pattern iron body swing check valves. Cutoff valves shall be equal to Crane No. 467 UL flanged pattern outside screw and yoke wedge gate valves. Cutoff valves up to 2" shall be bronze Crane No. 459 cut off valves; 2-1/2 and 3" shall be No. 467-1/2, 4" to 6" shall be equal to CLOW #F-5733.

2.4 DRAIN VALVES

A. Provide drain and test valves as required.

2.5 SIAMESE CONNECTIONS

A. Siamese Connection (Wall Type): Siamese connection to be W.D. Allen, or equal, Figure 276, 2-1/2" X 2-1/2" X 4", with independent clapper valves, caps, and chains all chrome plated brass. Provide ball drip equal to W.D. Allen Figure 2112 to drain siamese.

2.6 WATERFLOW ALARM VALVE

A. UL listed outdoor horn/strobe.

2.7 ELECTRIC SWITCHES

A. Provide all O.S.&Y. valves and indicator valves with tamper switches containing electrical contacts for supervision, and be connected to fire alarm system.

B. All electrical power wiring and interlock wiring will be provided and installed by the electrical contractor.

2.8 HANGER AND SUPPORTS

A. All piping shall be supported with UL approved hangers, types and sizes required, Grinnell or equal. Hangers shall be attached to structural steel work by clamping or other approved methods, except that structural steel works shall not be drilled or punched. Wherever necessary, furnish install and securely anchor to or between building members suitable angle iron or others steel members to support sprinkler work.

2.9 SPRINKLER HEADS, EXTRA SPRINKLER CABINET

A. Sprinkler heads shall be proper types, ratings and spacings for the areas involved. Provide 1 sprinkler cabinet with (12) extra sprinkler heads and sprinkler wrench for emergency use, at a point as directed by the Architect.

PART 3 - EXECUTION

3.1 TESTING

A. All piping in the sprinkler system, both inside and outside of the building, shall be tested at a water pressure of 200 psi for a period of not less than two hours. All bracing shall be in place and all air shall be removed from the system through the hydrants, drain valves, etc., before the test pressure is applied.

3.2 CLEANING

A. During the progress of the work, keep the premises reasonably clean as regards trash, debris, etc., caused by his materials and workmen. After all work has been completed and prior to final inspection, all equipment shall be thoroughly cleaned and all trash and debris removed from the job site.

3.3 INSTALLATION

A. All sprinkler work including the installation of underground fire main shall be installed by a Licensed Registered Fire Protection Contractor. Underground fire mains and hydrants shall be installed and in service prior to construction.

B. Install piping with ample flexibility to permit free expansion and contraction of pipework without putting excessive stress on piping, supports, or equipment, or causing damage or breakage. Do not bend any pipe. Ream pipe ends after cutting pipe. For threaded joints, use suitable non-hardening tape. Screw flanges to cast iron and ductile iron pipe; screw or weld flanges to steel pipe.

C. Pipe passing through pit walls, building walls, and building floors below grade shall be provided with sleeves of standard weight galvanized steel pipe. The annular spaces between pipe and sleeves shall be sealed with link seal hydro-static pipe wall seal. Sleeves shall be sized as follows:

3" pipe - 8" ID sleeve
4" pipe - 10" ID sleeve
6" pipe - 12" ID sleeve

3.4 SPRINKLER SYSTEM

A. Systems shall be wet type as required by N.F.P.A. 13.

B. Head spacing to be ordinary hazard - light hazard as required by N.F.P.A. 13.

C. System shall be hydraulically calculated by a licensed sprinkler contractor.

D. All areas shown on the Architectural drawings shall be provided with automatic sprinkler protection.

E. Sprinkler protection in freezers, cold rooms, and like occupancies shall be provided with automatic sprinkler protection and dry pendent heads shall be utilized.

F. Sprinkler heads subject to mechanical damage shall be provided with approved type wire guards.

G. Sprinkler and fire lines shall be run in concealed ceiling space and chrome pendent sprinkler heads utilized in all areas that have finished ceilings.

H. Areas that do not have a finished ceiling, sprinkler, and fire lines shall be exposed; and brass upright sprinkler heads shall be used.

I. All sprinkler heads installed for light hazard occupancy shall be quick response type in accordance with N.F.P.A. 13.

J. Dry pendent heads shall be installed in walk-in coolers and freezers.

K. All underground sprinkler work including fire hydrants shall be installed and completed prior to building construction.

END OF SECTION 21 05 00

SECTION 22 05 00 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. It shall be the contractor's responsibility to furnish and install complete all systems, equipment, and related items described under Division 22.

B. It shall be the Contractor's responsibility to determine the characteristics of electrical currents available to operate the mechanical equipment prior to ordering such equipment. All electrically operated equipment shall be designed for operation with the type of electric current available to the project.

C. It shall further be the Contractor's responsibility to locate, layout and make provisions for all openings required in precast or cast in place concrete slabs, etc., necessary to accommodate his work.

D. Do all excavation and backfilling required for the installation of piping and other mechanical work underground.

E. Provide labor, materials, tools, and services for a complete installation of equipment and systems specified herein and indicated on drawings.

F. All equipment shall be installed in accordance with the manufacturer's drawings and recommendations.

G. The Contractor shall furnish and install all rough-in work and make final connections to all equipment requiring water, gas, drains, ductwork and other mechanical work required for connection to equipment furnished under this contract.

H. The equipment shall be properly prepared structurally and mechanically ready to receive a single connection for each of the various mechanical items with all plumbing, piping drains, traps, tailpieces, supply fittings, gas lines, etc., internal to and part of the equipment installed by the equipment manufacturer or supplier.

I. Verify all connections and rough-in locations with the Architect and / or the equipment supplier or contractor prior to the start of their work. Do not scale plumbing drawings.

J. Contractor agrees to assume responsibility for liability, workmanship and quality of materials concerning work sublet to others. Before part of contract is sublet, submit to Architect in writing names of proposed subcontractors and obtain written approval.

K. Related Documents: General conditions, Supplemental General Conditions, and General Requirements are part of this division.

1.2 CODES AND FEES

A. All work shall be installed in accordance with the applicable provisions of the local codes, latest adopted International Plumbing Code, NFPA, AGA, UL, AWWA, ASTM, ASME and ANSI.

B. The Contractor shall pay for fees and inspections as may be required for water, sanitary sewer and gas service, and all other systems such as the sprinkler system requiring inspection by agencies having jurisdiction.

1.3 ELECTRICAL WORK

A. All control wiring and conduit not shown on Electrical drawings shall be furnished and installed under Division 22 according to the National Electrical Code and Division 26 requirements. See G.2.

B. All power wiring and conduit for items furnished under Division 22 shall be furnished and installed under Division 26. See G.1.

C. All disconnects shall be furnished and installed by Division 26.

D. Toggle switches for 1/2 HP motors and less shall be furnished and installed by Division 26.

E. Wiring and conduit for solenoid valves, and control transformers including the transformers shall be furnished and installed by Division 22.

F. Division 26 shall install all starters, toggle switches, disconnects, and all wiring to the respective motor or device. Wiring and conduit from starter to a controller shall be by Division 23.

G. Definitions
1. Power wiring: Line voltage circuitry rough-in including conduit, boxes, conductors, etc. between the overcurrent protection and the equipment including the connection of the starters.
2. Control wiring: Any voltage circuitry rough-in including conduit, boxes, conductors, etc. between control activator and the controller or starter.

H. Conduit: All power wiring and 120V control wiring shall be in conduit. Low voltage control wiring shall be installed in conduit where exposed, or in return air plenums, in masonry walls, or below slab.

1.4 VISIT TO JOB SITE

A. Before submitting bid, Contractor shall visit the job site for the purpose of examining the site and conditions under which the work must be performed. No extra will be allowed for situations arising from failure of Contractor to thoroughly familiarize himself with site and existing building conditions, including charges and requirements to utilities as shown for the project.

1.5 RECORD DRAWINGS

A. The Contractor shall maintain a set of prints that reflect site conditions including location of valves, underground piping, equipment, etc. that have been changed to suit job conditions. The contractor shall prepare a corrected reproducible tracing of the project using the results of the record print. Final payment shall not be made until such document(s) is turned over to the architect upon completion of the project.

1.6 QUALITY ASSURANCE

A. Perform work of this section using skilled workers who are trained and experienced in the required crafts and who are knowledgeable and familiar with the specified requirements and the methods to be used for proper performance of the work.

1.7 COMPLETE WORK

A. Contractor shall provide and install all systems in complete working order. All items normally required for operation shall be provided.

1.8 SEISMIC DESIGN

A. All piping and equipment supports shall be installed according to Chapter 16 of the International Building Code based on specifified determined site classification.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

A. All pipe lines installed under the contract shall be clearly labeled to indicate their function and flow direction. Labels shall be applied by stencil, decal, printed tape, or equivalent method, and shall be so spaced that the lines may be traced from start to finish. Labels (where used) shall be Seton "Setmark" or approved substitute.

B. Round brass tags shall be provided to identify the function of each valve in the various piping systems, except valves for which the purpose is self evident. Tags shall be approximately 1½" in diameter, properly stamped and securely fastened to the valve. A valve tag list showing valve tag number, and valve type and function shall be framed under clear plastic glazing and placed in main mechanical room.

C. All starters and pushbutton stations shall be labeled to identify the equipment which they control, utilizing Kroy Duratype 240 SE industrial tape, and suitable labeling machine or approved substitute.

D. All equipment shall be labeled with drawing mark number utilizing engraved plastic laminate nameplates. Nameplates shall be Seton "Setonply" or approved substitute.

E. All air unit thermostats shall be labeled with proper mark number identifying it with air unit it serves, utilizing Kroy Duratype.240 SE industrial tape, and suitable labeling machine or approved substitute.

F. All valves above the lay-in tile ceiling shall have black bakelite locator plate with white letters attached to the tee bar with pop rivets or sheet metal screws. The tag shall be 1" wide with 3/4" high letters. The length shall be as required. A tag shall be placed for the following piping:
   1. DOMESTIC WATER, NATURAL GAS, HOT WATER, HOT WATER RETURN.
   2. Each tag shall have an arrow pointing to which ceiling tile should be removed to access each valve.

2.2 EQUIPMENT LIST, SHOP DRAWINGS AND SAMPLES

A. Submit to the Architect for approval, within 30 days after receipt of Notice to Proceed with the work, detailed shop drawings of all equipment and all material required to complete the project. The shop drawing shall be complete as described herein. The Contractor shall furnish the number of copies required by the General and Special Conditions of the Contract, but in no case less than six (6) copies.

B. **All shop drawings to be submitted at one time in a 3-ring binder with cover and drawing index sheet or electronically.**

C. The shop drawings shall be detailed, with dimensioned drawings or catalog cuts, showing construction, size, arrangement, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be a standard catalog product of an established manufacturer and of equivalent quality, finish, and durability to that specified. Submission material and all shop drawings for the various items of equipment shall be marked with the respective mark number or identification of the equipment shown on the drawing or in the specification.

D. Provide a cover sheet for all major equipment, including but not limited to, pumps, plumbing fixtures, boiler, water heaters, that shall list in detail all accessories called for in specifications and on drawings that are being supplied.

E. The contractor shall verify all electrical requirements of equipment with the electrical service available before ordering said equipment.

F. Approved shop drawings do not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings or specifications.

PART 3 - EXECUTION

3.1 TESTS

A. Test all plumbing piping, following installation, but before it is covered or connected to the sewers or fixtures. Furnish necessary labor, materials and equipment for making test. All leaks disclosed by testing shall be reworked in an approved manner and the leaking system shall then be retested until proved tight under pressure. Test all systems for watertightness (or gas-tightness) as required by the authorities having jurisdiction, or in the absence of such requirements the minimum tests shall be made as follows:

1. Fill all storm and sanitary drainage and vent piping with water and allow to stand thus filled for 3 hours without showing leaks. Piping may be tested in sections, but no sections shall be tested with less than a ten foot head.
2. Test all water piping by applying a hydro-static pressure of not less than 100 pounds per square inch or 1½ times the working pressure, whichever is greater.
3. Test all gas piping systems with air or inert gas only. Test pressure shall be not less than five times the maximum pressure to which the piping will be subjected in operation for a period not less than 30 minutes.

3.2 COORDINATION

A. The plumbing work shall be installed as neatly as possible in the locations shown but shall be subject to such deviations, modifications and relocations as may be necessary to conform to the requirements of the architectural drawings and as necessary to avoid interferences with the structural work and the work of other trades, and interferences between the various trades. This shall be done at no cost to the Owner. No piping or equipment shall be installed which would require ceilings to be lower than required by drawings, unless approval is obtained from the Architect.

B. It is the responsibility of the General Contractor to coordinate the work of his subcontractors. To this end, the General Contractor shall require that the various subcontractors carefully examine and familiarize themselves with the architectural and structural drawings and drawings covering the work of other trades, and that they frequently consult with all other trades so that the work may be coordinated.

C. If necessary to coordinate and expedite the work, the Contractor shall prepare "interference drawings" and submit them to the Architect for approval. Such drawings shall show the work of the various trades involved, illustrate proposed details of construction and arrangement of equipment and apparatus, and clearly indicate any deviations from contract requirements.

D. Minor changes in arrangement may be made to suit unforeseen conditions, but no major deviation shall be made without written approval from the Architect. If any deviations are deemed necessary, submit all details of proposed changes and all reasons therefore, in writing, to the Architect for approval prior to making installation of such work.

E. Do not fabricate piping before interferences are verified. No extra will be allowed for piping fabricated in advance which cannot be used.

3.3 EXCAVATING AND BACKFILLING

A. Do all excavating and backfilling required for the installation of underground work required by the mechanical work.

B. Excavation depth for all trenches except water shall be not less than 12" and a separate trench is required for sewer, gas, and water. The distance between water and sewer lines shall not be less than 10 feet unless otherwise required by the Tennessee Department of Health. Width of trench shall be not less than 18" wider than the pipe outside diameter. Minimum cover over top of water pipe shall not be less than 30". Minimum cover for other pipe shall be not less than 24".

C. Copper piping, PVC piping, and gas piping shall be laid on a 6" bed of sand and backfilled with 12" of sand in 6" layers to 12" above top of pipe in areas not below slab or pavement. Complete backfilling with Tennessee Highway Class "B" aggregate to slab under building and outside of building to underside of pavement. The balance of the fill outside the building shall be clean earth thoroughly tamped and crowned to allow for subsequent settlement. Compact to 100% density under buildings and paved areas.

D. Cast iron sewer and cast iron water lines shall be laid on a 6" bed of class "B" aggregate and backfilled with class "B" aggregate to 12" above top of pipe in 6" layers in areas not below slab or pavement. The balance of fill outside the building shall be clean earth thoroughly tamped and crowned to allow for subsequent settlement. Completely backfill trench with aggregate in areas below slab and below pavement.

E. All trenches shall be braced as required to protect workmen and adjacent work. Comply with local regulations or, in absence thereof, with provisions of the "Manual of Accident Prevention in Construction", of the AGC.

3.4 CUTTING AND REPAIRING

A. All chases, recesses, sleeves and other openings in masonry and concrete shall be built in as the construction work progresses, and it shall be the responsibility of the subcontractor to see that such chases, recesses, sleeves and other openings required for their work are properly located and installed. If this is not done by the subcontractor whose work required such accommodation, it shall be performed at his expense.

B. Structural members or finished work shall not be cut without the express permission of the Architect. Cutting shall be done neatly and patching or repairing shall match adjacent work.

3.5 PROTECTION AND CLEANING

A. Work shall be protected at all times. Pipe openings shall be closed with caps or plugs until permanent connections are made. Fixtures and equipment shall be covered, if necessary, to protect against dirt, water, chemical or mechanical damage or defacement. The installation of fixtures liable to damage shall be deferred by the Architect.

B. Upon completion of the work and after all tests have been made and piping systems proven tight, clean all fixtures and equipment, traps, dirt pockets, water tanks, circulating systems, filters, etc., and leave in correct operating condition. No air unit shall be operated without filters.

3.6 OPERATING INSTRUCTIONS

A. Furnish the services of competent personnel to instruct the Owner's personnel in the proper operation and maintenance of all equipment, for a period of not less than 1 working day.

B. Furnish and deliver to the Owner three sets of operating instructions for all equipment installed under this contract, including shop drawings, piping diagrams, wiring diagrams, maintenance recommendations and information concerning replacement parts. This information must contain plumbing contractor names, equipment supplier names, contact personnel, telephone numbers, and facsimile telephone numbers. This information shall be contained in a three ring binder of suitable size, and labeled on the exterior with project name.

3.7 GUARANTEE

A. The Contractor shall guarantee all work to be in accordance with contract requirements and free from defective or inferior materials, equipment, and workmanship for a period of one year, and he shall guarantee that all equipment is of proper size and design and so installed as to produce the capacities and results specified and shown on the drawings.

3.8 SUBSTITUTIONS

A. Substitution approval shall be at the sole discretion of the Engineer.

B. Contractor shall note on shop drawings all major differences from specified material or equipment.

C. When making requests for substitutions, Contractor assumes the following responsibilities:
1. To have personally investigated the proposed substitute product and determined it is equal or superior in all respects to that specified;
2. To provide the same warranty for substitute that Contractor would for that specified:
3. To provide complete cost data, and waive all claims for additional costs related to substitution, which subsequently become apparent; and
4. To coordinate installation of the accepted substitute, making such changes as may be required for Work to be complete in all respects, including those of other disciplines.

D. All requests for substitution must be submitted to the architect and engineer a minimum of 14 calendar days prior to project bid date. Such submission does not constitute approval. Only items or manufacturers specifically stated in the project specifications, drawings or addenda for use shall be considered as approved.

END OF SECTION 22 05 00

SECTION 22 05 10 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General provisions of Division 22, General and Supplementary Conditions, and General Requirements of Division 1, apply to this section.

1.2 BASIC REQUIREMENTS

A. Equipment and materials used in the work shall be in accordance with the contract documents, of the best quality and grade for use intended, shall be new and unused and shall be the manufacturer's latest standard or current model for which replacement parts are readily available.

B. Work shall be installed under the constant supervision of a competent superintendent and by skilled and competent mechanics experienced in the trade that contractor is practicing.

C. All apparatus and equipment shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations. All auxiliary piping, water seals, valves, electrical connections, etc., recommended by the manufacturer or required for proper operation shall be furnished and installed complete.

D. The work of this section is subject to the requirements of the Mechanical General Provisions and the General Provisions in Division 1.

PART 2 - PRODUCTS

2.1 SLEEVES AND PLATES

A. All pipes that pass through masonry partitions and walls and concrete floor slabs shall be installed with standard weight galvanized steel sleeves. Sleeves through floors shall be long enough to project a minimum of 2" above finished floor. Sleeves shall be large enough for pipe, pipe insulation and required fire caulking. Sleeves in concrete shall be accurately located in the forms and secured in place to prevent displacement during pouring of concrete. Sleeves below grade in exterior walls shall be Link-Seal with wall penetration seal or approved substitution.

B. Sleeves in finished spaces shall finish flush with the finished wall surface. Sleeves for insulated water or refrigerant pipe shall be large enough to accommodate the insulation.

C. Pipes passing through masonry walls and partitions in finished spaces shall be fitted with metal escutcheons or collar plates. Plates occurring in painted walls or ceiling shall be prime coated for painting; other plates shall be chromium plated.

D. Exposed ducts passing through finished walls shall be furnished with sheet metal escutcheons.

E. All pipe penetrations of fire rated floors or walls are to be protected. Space between metal pipe and wall or sleeve shall be protected with Hilti Fire Barrier Penetration Sealing System or approved substitute. Installation shall be in accordance with the manufacturers recommendations for the hourly fire rating of the partition. The system shall be U.L. listed. For insulated chilled water, domestic cold water and refrigerant pipe, continue insulation and vapor barrier through wall. The sleeve through the wall shall be large enough for the pipe, insulation and fire caulking.

F. PVC pipe passing through rated walls, ceilings or floors shall have Hilti UL Listed Fire Protection System or approved substitute. System number shall be as required by construction and rating.

2.2 ACCESS PANELS

A. Furnish steel access panels, not smaller than 12" for single valve and 12" X 24" or 18" X 18" for two or more valves, for access of concealed valves, traps, clean outs, unions, dampers, etc., where no other means of access is shown or specified. Access panels shall be turned over to the general contractor for installation.

B. Panels shall be Milcor, or approved substitute, with screw driver operated cam latch, and of proper design and style for installation in wall, floor or ceiling construction called for on architectural drawings. Access panels in fire rated construction shall have a UL label Class B rating. All panel styles to be verified by the Designer.

2.3 PIPE FITTINGS

A. Screwed Fittings - Screwed fitting for steel pipe shall be 150 pounds malleable iron banded fittings, except where cast iron drainage fittings are specified. Fittings for copper pipe shall be wrought copper or cast bronze, equal to those manufactured by Mueller Brass Co., Bridgeport Brass Co., NIBCO, or approved substitute. Pipe size 2½" and larger shall be flanged type.

B. Dielectric Fittings - Dielectric Fittings or Union between dissimilar metals shall be EPCO, or approved substitute. Provide 3/AWG copper bonding strap around each dielectric union.

C. Unions:
   1. Unions, either screwed or flange, shall be installed on each side of all special valves, regulators, etc., on one side of each check valve and each

trap, and at all equipment such as coils, tanks, compressors, pumps, etc., so that such equipment may be readily disconnected. No unions shall be placed in a location which will be inaccessible after completion of the building.

2. Where flanged valves, regulators, etc., do not permit the removal of flange bolts, two such devices shall be separated by a spool.
3. Connections between pipes of dissimilar metals shall be made with Dielectric (insulated) unions.

2.4 METERS, GAUGES AND THERMOMETERS

A. Gauges and Test Plugs
1. Water pressure gauges shall be Ashcroft, or approved substitute, drawn case type 4½" dial size, and range as shown on the drawings.
2. All temperature and pressure gauge test connections indicated on the drawings shall have Universal Lancaster Needle Adapter and brass pressure test plug. Brass test plugs shall be installed at locations shown on the drawings for occasional tests. Furnish two thermometers and pressure gauges and needle adapter for each pressure temperature range indicated on the drawings.

B. Thermometers
1. Water Thermometers shall be red reading, mercury type, with 9" scale length, and shall be Moeller 17103 or 27103, or approved substitute, as required. The range shall be as shown on the drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. Run exposed piping parallel to the principal parts of the building. Piping shall be run concealed when provisions are made in floors, walls, ceilings and chases through all finished spaces, except at fixture connections and where specifically noted otherwise. Do not run water pipe below ground floor slab except where indicated.

B. Piping, and equipment shall be kept as close as possible to ceilings, walls, columns, etc., and shall be installed in such an orderly manner as to take up a minimum of space and allow a maximum of headroom, and all offsets, fittings, etc., required to accomplish this shall be furnished and installed, whether or not each offset and fitting is specifically shown or noted. Minimum clearances on exposed piping shall be maintained as specified under "Piping Clearances" herein.

3.2 PIPE INSTALLATION

A. Service pipe, valves, fittings, etc., shall be so installed that after the insulation cover is applied there will be not less than ½" clear space between the finished

covering and other work and between the finished covering of parallel and adjacent pipes. The clearances on uninsulated pipe shall be measured from the point of greatest projection of the pipe fittings.

B. Fastenings to masonry walls shall be made with metal expansion sleeves, cinch anchors, toggle bolts, or equal. Fastenings to concrete shall be made with metal expansion sleeves, metal inserts. Wood plugs will not be acceptable in any case.

3.3 JOINTS IN PIPE

A. PVC pipe joints shall be made with cement recommended by pipe manufacturer. All joints shall be cleaned with approved solvent.

B. Threaded pipe joints, except as otherwise specifically noted, shall be made with approved non-corrosive pipe joint compound, using a thin coat on the male threads only. Ends of pipe shall be reamed free from burrs and threads shall be clean-cut and tapered.

C. Type "L" copper pipe joints, except as otherwise specifically noted, shall be made with 95-5 plumber's solder and noncorrosive paste flux. Acid core solder shall not be used. Tubing shall be square cut on a sawing vise and reamed to remove burrs. Outside and inside of fittings and outside of pipe shall be well cleaned and steel wool used before soldering. Soldering operations shall be performed strictly in accordance with the recommendations of the manufacturer of the pipe and fittings. Joints in copper pipe Type "K" below grade shall be made with high temperature solder, silver solder, sil-fos, or equal.

D. Connections of copper pipe to ferrous pipe shall be made with Dielectric unions. Connections of metal pipe to non-metallic pipe shall be made with adapters as specified hereinbefore. Connections of copper piping to equipment requiring threaded connections shall be made with adapters as specified hereinbefore.

E. Unions for brass or copper pipe shall be all brass, and for steel pipe shall be malleable iron with brass insert. Unions 2" and smaller shall be ground joint type.

F. All welding shall conform to the ASME Standard B31 and the ASME Boiler and Pressure Vessel Code. All welds shall be of the single "V" butt joint-type with optimum fusion and 100% weld penetration of wall thickness of piping. Direct welded connections shall not be made to valves, strainers, equipment, etc. A certificate shall be obtained from the Contractor indicating that certifications of all pipe welders and welding procedure specifications for the project be qualified, in accordance with Section IX of the ASME Code.

END OF SECTION 22 05 10

SECTION 22 05 29 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 WORK DESCRIPTION

A. Provide all labor, equipment, materials, etc. required to complete installation as specified herein and/or shown or scheduled on the drawings.

B. Support (1) from wood using coach screws on open construction and hanger flanges on sheeting, (2) from concrete using inserts, (3) from steel using beam clamps, rivets or bolts, (4) from concrete blocks using toggle or through bolts. Fasten supports to building in following order of preference: (1) steel framing, (2) concrete, (3) wood framing, (4) masonry, (5) wood sheathing. Do not support from roof deck without approval. Do not use plastic wall anchors. All hangers, rods, and inserts shall be Underwriters Laboratories approved for the service intended and shall meet MSS #SP-58 & 69.

C. Adhesives are not acceptable as mounting or supporting devices.

PART 2 - PRODUCTS

2.1 HANGERS

A. Use adjustable swivel ring band type for pipe 2½" and smaller. For pipe 3" and larger, unless otherwise noted, use adjustable steel, clevis type.

B. At each hanger on insulated pipe provide (1) pipe covering protection saddles on hot lines and (2) insulation shields on cold lines.

C. Saddles to be 16 gauge, minimum 12° saddles arc with the following minimum saddle lengths:

Pipe Size	Minimum Saddle Length
1	12"
2	12"
3	12"
4	12"
6	12"

D. Hanger surface material shall be such that there will be no possibility of electrolytic corrosion between hanger and pipe.

E. Anchors requiring explosive charges shall not be used. Phillips "Red-head" shields can be used for loads under 300 lbs.

PART 3 - EXECUTION

3.1 HORIZONTAL PIPING SUPPORT SCHEDULE

	Pipe Size	Rod Dia.	Steel Max. Spac.	Copper Max. Spac.	PVC Max. Spac.
1)	up to ½"	¼"	6ft.	4ft.	3½ ft.
2)	3/4" to 1"	3/8"	7ft.	5ft.	4ft.
3)	1¼"	3/8"	7ft.	7ft.	5ft.
4)	1½"	3/8"	8ft.	8ft.	5ft.
5)	2"	3/8"	10ft.	8ft.	5ft.
6)	2½"	½"	11ft.	9ft.	6ft.
7)	3"	½"	12ft.	10ft.	6ft.
8)	3½" to 4"	5/8"	14ft.	11ft.	6½ft.
9)	6"	3/4"	17ft.	--	7½ft.
10)	8"	7/8"	18ft.	--	8ft.

3.2 METHOD

A. Provide hanger within 18" of each elbow, also provide hanger within 18" of connection to each piece of equipment.

B. Support vertical pipe at base and at each floor. In addition, 1" or smaller copper pipe shall be supported at 5 foot intervals.

C. Where maintenance requirements may impose torque, as at a cleanout, support on both sides of torque point.

D. When supporting PVC pipe, provide 18 ga. 12" long shield at each hanger.

E. Pipes passing thru walls shall not bear on building construction.

F. Where pipes carry material colder than 90°F, except domestic cold water, hangers shall be sized to fit outside diameter of insulation. Provide shields at each hanger. On 2½" and larger pipe, insulated with fiberglass, provide calcium silicate insulation at hangers.

G. All floor-mounted equipment shall be mounted on a reinforced concrete base covering the complete floor area of equipment. This concrete base shall be 4" high and shall extend 3" beyond the equipment on all sides. Provide all necessary anchor bolts and templates. Provide ¼" thick layer of non-shrinking grout between floor-mounted machinery and concrete pad. Where equipment mounts on structural steel, provide shims.

H. Any piece of equipment installed in a finished ceiling, or wall area, shall be supported independently of the building finish. Ceiling-mounted items shall be supported directly from the building structure except, with Engineer's written approval, can be from ceiling suspension system if the hanger load is less than 10 lbs.

I. Suspended equipment shall be supported from building structure by adjustable rods.

END OF SECTION 22 05 29

SECTION 22 07 00 - INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, General and Supplementary Conditions, and General Requirements, apply to this section.

1.2 WORK INCLUDED

A. Work required under this section consists of insulation for piping systems and equipment as hereinafter specified.

B. The work of this section is subject to the requirements of the Plumbing General Provisions and Basic Material Specifications.

1.3 BASIC REQUIREMENTS

A. All materials used for insulation of pipe and ducts and equipment covered in this section shall be UL listed. Fire hazard ratings shall be as follows:
   1. Flame spread of 25, and smoke development of 50 for all duct insulation and other insulation located in ceiling plenums or rooms utilized for return air plenums.
   2. Flame spread of 25 and smoke development of 200 for other pipe and equipment insulation.

B. Increase the insulation thickness of ½" on all piping outside the building insulation envelope and weatherproof with 0.016" thick aluminum jacket with aluminum fitting covers. This piping shall be protected with electric heat tape installed under the insulation.

C. All insulation and thicknesses are selected to meet the International Energy Conservation Code.

D. Install 0.016" thick aluminum jacket on all pipe insulation in mechanical rooms 7'-0" from finished floor.

PART 2 - PRODUCTS

2.1 FIBERGLASS FOR PIPE

A. Provide 4-pound density 500°F snap-on type glass fiber with factory applied Owens Corning Paper Free ASJ Jacket and SSL II Closure System with vapor barrier. Fitting, including ells, valves and tees, shall be insulated with snap-on preformed insulation the same thickness as pipe insulation and finished with glass fabric and vapor barrier mastic. Use foam glass half sections at hanger saddle

on pipe sizes 2" and larger to eliminate insulation deformation. Insulation to have a minimum "K" value of .023 @ 75°F mean temperature. Provide this insulation for the following:

1. Domestic cold water - 1" thick.
2. Domestic hot water and hot water return - 1" thick.
3. Horizontal rainwater leaders and overflow drainage piping - 1" thick.
4. Cold condensate drains - 1" thick.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all insulation products in strict accordance with manufacturer's instructions.

B. All items requiring service such as strainers, balancing valves, etc., provide removable insulation caps of insulation equal in thickness to pipe covering.

C. Cover all joint, rips, tears, punctures, staples, insulpins or breaks in vapor barrier jacket with 4" wide woven glass fabric tape embedded in vapor barrier fire resistant mastic.

D. No insulation shall be cut where a hanger is located.

E. Flexible tubular elastomeric piping installation shall be as follows:
   1. Valves, flanges, backflow preventers, strainers, and couplings shall be insulated using Armaflex donuts that shall then be covered with sheet or oversized tubular insulation.

END OF SECTION 22 07 00

SECTION 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 91 13 – General Commissioning Requirements

C. Section 23 08 00 – Commissioning of HVAC

D. Section 26 08 00 – Commissioning of Electrical Systems

1.2 COMMISSIONED SYSTEMS

A. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning verifies that systems are operating in a manner consistent with the Contract Documents.

B. Refer to Part 3 of this section for a detailed list of equipment included in each commissioning activity.

1.3 RESPONSIBILITIES

A. The Contractor shall be responsible for scheduling, supervising and performing start-up, testing and commissioning activities specified in this section and necessary to demonstrate to the Owner successful operation of the commissioned systems.

PART 2 - PRODUCTS

2.1 MEANS OF ACCESS

A. The Contractor shall provide means for the CxA to access, observe and visually confirm proper operation of all equipment and systems. These means shall be in compliance with all OSHA and job-site safety regulations.

2.2 TEST EQUIPMENT

A. The Contractor shall provide the necessary equipment to fully test the commissioned systems as defined in the functional performance test procedures to be provided by the CxA.

PART 3 - EXECUTION

3.1 EQUIPMENT PRE-FUNCTIONAL CHECKLISTS

A. Equipment installation checklists, provided by the CxA, shall be completed by the Contractor on the following systems:
   1. Domestic Hot Water Heaters
   2. Domestic Hot Water Heater Circulating Pumps

3.2 FUNCTIONAL PERFORMANCE TESTS

A. The Contractor shall provide all documentation as requested to the CxA for development of functional performance testing procedures. This documentation shall include, at a minimum, manufacturer installation, start-up, operation and maintenance procedures. The CxA may request further documentation as necessary for the development of functional performance tests.

B. Functional performance tests shall be performed on the following systems (sampling rates are indicated in parenthesis):
   1. (2) Domestic Water Heaters (100%)
   2. (2) Domestic Hot Water Circulating Pumps (100%)

C. The above sampling rates are to be considered a minimum. The contractor is expected to perform functional testing on 100% of commissioned equipment but no less than shown above.

D. The Contractor shall review the functional performance test procedures developed by the CxA.
   1. The Contractor shall respond in writing to the CxA regarding the acceptability of the proposed test procedures.
   2. The Contractor shall note any necessary modifications to the procedures due to the actual equipment/systems or safety concerns and shall submit these to the CxA for consideration.

E. The Contractor shall place equipment and systems into operation and continue the operation as required during each working day of the testing activities.

F. The Contractor shall accomplish the functional performance testing of equipment based on procedures developed by the CxA and as reviewed by the Contractor.
   1. The Contractor shall provide skilled technicians to operate the systems during functional performance testing. At a minimum, the contractor should provide one trade technician familiar with the system being tested and one controls technician to operate the system through the BAS.
   2. The Contractor shall correct any deficiencies identified during testing and retest equipment as required.

G. Functional performance testing is intended to begin upon completion of a system. Functional performance testing may proceed prior to the completion of the system at the discretion of the CxA and the Contractor.

H. Functional testing shall verify all sequences of operation defined in the Contract Documents for the commissioned equipment and systems.
   1. Testing shall occur by overriding setpoints or sensor readings at the BAS or by other means mutually agreed to by the Contractor, the CxA, and the Owner to initiate sequences of operation and verifying the response of the system.
   2. Sequences of operation shall be verified under normal power, emergency power, and fire alarm scenarios.

I. Upon successful completion of all functional performance tests, the Contractor(s) shall perform Integrated Systems Testing. The testing shall document and verify the proper response of all Division 22 systems to all potential utility and emergency power operating and failure scenarios.

3.3 DEFERRED FUNCTIONAL PERFORMANCE TESTING

A. The Contractor shall perform any deferred testing as required to properly demonstrate successful operation to the Owner.
   1. Some test conditions may not be able to be simulated and thus require these actual conditions to be present to implement the test.
   2. A mutually convenient time to the Owner, CxA and Contractor will be scheduled when these test conditions will be present to conduct this deferred testing.

B. The Contractor shall perform these tests as indicated in the functional performance test procedures.

C. The Contractor shall correct any deficiencies or failures identified in the process of performing these tests.

END OF SECTION 22 08 00

SECTION 22 10 00 - PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, General and Supplementary Conditions, and General Requirements, apply to this section.

1.2 DESCRIPTION OF WORK

A. Labor, material, equipment and services necessary to provide a complete plumbing system.

B. Examine carefully architectural, equipment, electrical, mechanical and structural drawings and each division of this specification for items not a part of this plumbing section which may require plumbing connections. Unless explicitly indicated to the contrary, Contractor shall provide necessary supply, waste and vent lines, and make final connections to such items. It shall be Contractor's responsibility to locate supply, waste and vent lines, to such items in conformity with approved manufacturer's rough in drawings.

1.3 PLUMBING SYSTEMS

Work included under this section consists of plumbing work, principal systems of which are as follows:

A. Water Supply System: Extend and connect hot and cold water to fixtures and equipment provided under this and other sections.

B. Waste Piping System: Provide sanitary waste drainage and vent piping including connecting fixtures provided under this and other sections.

C. Storm Drainage System: provide storm drain piping inside building including rainwater leader system, roof drains, etc.

D. Plumbing Fixtures: Provide plumbing fixtures, trim and related items such as supplies, traps, drains, cleanouts, water closet seats and covers, fixture supports and other accessory items.

E. Natural Gas System: Provide complete system to all gas fired equipment.

F. Condensate Drainage System: Provide complete collection system for condensation from HVAC equipment and route to nearest floor drain or as otherwise indicated on drawings.

G. Compressed Air Piping System: Provide air compressor and extend air pipingto all air outlets.

1.4 CONNECTIONS FOR EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall furnish and install all roughing-in connections for Kitchen and all other equipment requiring water, drains, etc. The equipment manufacturer shall furnish shop drawings to the Contractor who shall rough-in accordance with these shop drawings, and make final connections. Plumbing requirements at locations indicated are based only on specified equipment. Rough-ins may vary slightly pending equipment purchased. Verify rough-ins with shop drawings or purchased equipment.

B. After the equipment supplier has set his equipment, the mechanical contractor shall make all necessary connections. Contractor shall provide all stops, supplies, traps, tailpieces, press reducing valves, vacuum breakers, etc. as required to make each sink or piece of equipment operable.

C. Drain connections from dishwashers, booster heaters, steamers and kettles shall be type “M” copper routed to floor sinks and/or trench drains. Waste lines from above mentioned floor sinks and/or trench drains shall be Bell & Spigot cast iron pipe and fittings in locations identified on the kitchen plumbing plans.

PART 2 - PRODUCTS

2.1 WATER CIRCULATING PUMPS

A. In-the-line circulators to be all-bronze construction and provided with flanged connections; hardened steel shafts; bronze-sheathed, diamond-bored sleeve bearing; bronze impellers; and mechanical seals.

B. Motors to be flexible-coupled, supported from pump casing and provided with a manual motor starter complete with thermal overload protection.

C. Units shall come complete with strap-on aquastats to control pump operation.

D. Electrical characteristics and capacities shall be as scheduled on drawings.

E. In-line-circulators shall be by Bell and Gossett, Grundfos or approved substitute.

2.2 BACKFLOW PREVENTERS

A. Backflow preventers on lines 3/4" through 2" pipe size shall be Watts No. 900 Series, Wilkins Model 975ELS, or approved substitute, complete with gate valves, strainers, test cocks installed with required air gap at vent opening to drain line.

B. Backflow preventers on lines 2½" through 6" pipe size shall be Watts No. 909 Series, Wilkins Model 375FSC or approved substitute, complete with gate valves, test cocks installed with required air gap at vent opening to drain lines. Contractor shall install line size strainer on inlet side of the assembly.

C. All backflow preventers shall be complete with funnel and required air gap. Pipe discharge to nearest suitable drain.

D. All backflow preventers must be installed above grade in non-flooding locations.

2.3 INTERIOR WATER PIPING

A. Piping above Ground: Piping 4" and smaller shall be ASTM B88 hard drawn Type L copper assembled with wrought copper solder fittings. Piping larger than 4" shall be ductile iron pipe, class 50, with ductile iron fittings.

B. Piping Below Slab: All piping shall be Type K Soft Drawn Copper, ASTM B-88.

C. Brass or bronze adapter fitting shall be used where necessary and shall be iron pipe size and thickness where required for fixture or equipment connections. Connections of copper pipe to ferrous pipe shall be made with dielectric unions or couplings.

2.4 MANUAL VALVE

A. Valves for Domestic Water:
1. On exposed C.P. connections, use C.P. valves.
2. Ball valves shall be used in sizes to and including 2" size. Valves shall be designed for service without removing from line and shall have Teflon seats.
3. Valves 2½" and larger shall be butterfly type with 150 PSI bubble-tight shutoff. Bronze Disc, EPT seat, multi- position handle and one-piece stainless steel stem.
4. Check valves shall be horizontal swing type, with grindable seat and metal disc. Size 2½" and smaller shall be Y pattern. All bronze size 3" and larger shall be iron body with bronze trim.

2.5 INTERIOR SANITARY SEWERS

A. Soil, waste and vent piping inside the building and to a point 5 feet outside the building walls shall be Schedule 40 PVC with D.W.V. fittings. PVC pipe shall not be used in return air plenums. In return air plenums, hubless cast iron pipe and fittings shall be utilized. Individual mechanical closets are return air plenums.

2.6 INTERIOR ROOF DRAINAGE

A. Interior roof drainage piping below and above grade to a point 5 feet outside the building walls shall be Schedule 40 PVC with D.W.V. fittings.

2.7 CONDENSATE DRAINAGE

A. Condensate drainage piping above grade shall be type "M" copper.

B. Condensate drainage piping below grade shall be schedule 40 PVC with DWV fittings.

2.8 GAS PIPING

A. Gas piping above grade 2" and smaller shall be ASTM A-53 black steel, assembled with malleable iron fittings, ground joint, unions and AGA cocks and ordinances.

B. Gas piping above grade larger than 2" or pressure of 5 pounds or more shall be black steel assembled by welded fittings.

C. Gas piping below grade, installed by this Contractor, shall be coated black steel pipe with welded fittings. Plastic may be utilized outside the building installed in accordance with local gas supplier. Installer must be certified in the installation of plastic gas piping.

D. The installation of the service meter, cocks, and regulators shall be in accordance with the requirements of local gas utility. High pressure gas line from the main to the service meter shall be installed by the local gas utility company. This Contractor shall make arrangements for the service meter and regulator and pay all costs for the installation, inspection fees, tests, etc.

E. All gas piping inside the building shall be run in ventilated spaces. Piping through walls shall be sleeved.

F. The contractor shall make arrangements with the gas utility to inspect the system and properly set all gas regulators in the piping system and pay all costs therewith. Furnish report of inspection to the Engineer.

2.9 CLEANOUTS

A. Cleanouts shall be Zurn, Wade, J.R. Smith, or approved substitute, and shall be installed full size of trap or pipe. Full size Y and T branches shall be provided for cleanouts as required by conditions at the building. Cleanout plugs shall be cast iron with neoprene or lead seals and shall be lubricated.

B. Cleanouts: (Zurn numbers listed):
   1. Exterior: ZN-1400-2, cast iron cutoff ferrule with round scoriated frame and cover, secured.
   2. Finished Concrete Floors: ZN-1400-2, Neolock Connection, round Nikaloy scoriated frame and cover.
   3. Ceramic Tile Floors: ZN-1400-3 Neolock Connection, with round Nikaloy scoriated frame and cover.
   4. Resilient Tile Floors: ZN-1400-7, Neolock Connection, with round recessed Nikaloy smooth round frame and cover.
   5. Wall: ZANB-1460-9 smooth round stainless steel access cover with securing screw.

6. Carpet Floor: ZN1400-15 Neolock Connection with round Nikaloy scoriated frame and cover with carpet marker.
7. Note: Use clamping device on cleanouts than occur in floors having waterproof membrane.

2.10 COMPRESSED AIR PIPING

A. Compressed air piping and fittings shall ve Schedule 40 galvanized steel.

2.11 ROOF DRAINS

A. Roof drains shall be Zurn, Wade, J.R. Smith or approved substitute installed with sump receivers, extension sleeves, and under-deck clamps as required by roof construction. See Architectural Details. Drain bodies shall be cast iron. Domes shall be cast iron.

2.12 PRESSURE REDUCING VALVES

A. Pressure reducing valves shall be installed as indicated on the drawings. The reducing valves shall be installed complete with inlet strainer, 3-valve bypass, and pressure gauges on the reduced and incoming pressure side. See detail on plumbing drawings.

B. Pressure reducing valves for water service 2" and smaller shall be Wilkins 600 or Watts U5B suitable for reducing pressure from approximately 300 pounds to 40 pounds. 3" and 4" water service, Watts 127-W or 2-1/2" & 3" Wilkins 500 or 4" Cal-Val 690-01-AB.

C. Pressure reducing valves shall be Watts, Wilkins, Cal-Val, or approved substitute.

2.13 PRESSURE GAUGES

A. Pressure gauges for water shall be 2½" dial size Ashcroft 1000, or approved substitute, with range required or noted on drawings. Install with gauge cock.

2.14 ELECTRIC WATER HEATERS

A. The electric water heaters up to 120 gallons size shall be U.L. Listed, fully automatic electric type with glass lined tank, insulated jacket, magnesium anode, drain valve, vacuum breaker in cold water piping if heater is not equipped with dip tube, insertion type high limit thermostat, insertion type control thermostat for each heater, ASME Code temperature and pressure relief valve installed in the top of the tank with discharge line to floor drains, janitor's sink or other suitable drain. All heater elements shall be insertion type for the electric power service noted on the drawings. The tank size and number of elements shall be as called for on the drawings. The units shall be Lochinvar, A. O. Smith, P.V.I., or approved substitute. Verify voltage available with the electrical drawings.

2.15 GAS WATER HEATER

A. Gas water heaters shall be AGA approved, with separate glass lined steel storage tank designed for not less than 125 pounds working pressure. Water heaters with storage capacity larger than 120 gallons or B.T.U. input greater than 199,999 shall be ASME Code Construction. The heaters shall have ASME Code temperature and pressure relief valves of adequate capacity installed in the tank and be fitted with discharge line to the floor drain. The heater shall have insulated jacket and be fully automatic with all safety and operating controls, electric control power ventor, and other controls where noted on drawings, safety pilot, gas regulator, draft diverter, and all other required trim. The storage tank and recovery rate shall be not less than called for on the drawings. The heaters shall be as manufactured by PVI, A.O. Smith, Lochinvar, complete as specified and noted on the drawings. Prior approval must be given to substitute from the manufacturers listed herein.

2.16 SHOCK ABSORBERS

A. Provide sealed air chamber type shock absorbers by Zurn in water lines which supply flush valves and solenoid valves, where solenoid valves are used. Placement of absorbers and size shall be as shown on drawings.

2.17 GREASE INTERCEPTOR

A. The grease interceptor shall be pre-cast concrete as detailed on the drawings.

2.18 PLUMBING FIXTURES

A. Contractor shall examine Architectural drawings for exact location and number of plumbing fixtures required. Architect/Engineer shall be notified of any discrepancies between the architectural and plumbing drawings prior to bidding. Failure to examine all drawings will not constitute a change order for fixtures to be added which were shown on one but not the other.

B. Refer to Architectural plans for rough-in dimensions. Do not scale plumbing drawings for rough-in dimensions.

C. Provide plumbing fixtures and drains as listed and described on drawings. Fixtures by Crane, Kohler, American Standard or Toto will be considered. Residential grade fixtures will not be accepted.

D. All fixtures designed for handicap use shall be mounted at handicap height as indicated by handicap code enforced in local area.

E. China or enamel fixtures to be white color, unless noted otherwise.

F. Drains to be Zurn, J.R. Smith,Wade or Watts.

G. Stainless Steel sinks shall be Elkay, or approved substitute.

H. Electric water coolers shall be Oasis, Halsey Taylor, or approved substitute.

I. Faucets shall be Symmons, Delta, T & S Brass, Zurn, Chicago or approved substitute.

J. Flush valves shall be Zurn, Sloan, Toto or approved substitute.

2.19 HANDICAP PLUMBING FIXTURE REQUIREMENTS

A. Plumbing fixtures designated for handicap usage shall be mounted at handicap height in accordance with the North Carolina Handicap Code and the Americans with Disabilities Act. Fixture heights and requirements are as follows:
   1. Adult fixtures
      a. Water closet - Height from finished floor to top of seat shall be 17"-19". Flush control shall not be higher than 44" above finished floor.
      b. Urinal - Urinal must have extended lip with height of lip 17" above finished floor. Flush control shall not be higher than 44" above finished floor.
      c. Lavatory - Lavatory rim shall be 34" maximum above finished floor maintaining 27" clear space below the basin at 8" from the front rim of the bowl toward the wall.
      d. Drinking fountain, electric water cooler - While maintaining 9" minimum foot space, 27" must be the mounting height from finished floor to bottom of leading edge.

PART 3 - EXECUTION

3.1 DOMESTIC WATER PIPING

A. From cold water main extend distribution mains, risers, and branches to all equipment and fixtures requiring cold water connections. From hot water generators extend similar lines to all equipment and fixtures requiring hot water connections.
   Install a valve in each major branch take-off in the hot and cold water distribution mains and elsewhere as necessary for control of the system or as shown on the drawings.

B. Water supply piping shall be run so that the system can be drained at the low point by opening valves; provide drain valves at low points, 3/4" size if not otherwise noted. Run piping concealed in chases, pipe shafts, and space above ceilings throughout finished spaces, except at fixture connections and elsewhere as specifically noted otherwise.

3.2 CHLORINATION OF DOMESTIC WATER LINES

A. After the domestic water piping system has been tested and cleaned, the system shall be sterilized in accordance with the requirements of the State Department of Public Health by the following method:

1. Introduce HTH solution, chlorine gas, or similar chlorination agent in sufficient quantity to produce a residual of 50 ppm of chlorine, as determined by residual chlorine tests at the ends of lines, and allow to stand for not less than 24 hours. Fill the lines slowly and open and close all valves while the chlorine is being introduced into the system.
2. After the disinfecting solution has been left standing for 24 hours, flush out the system until all traces of the solution are removed. If after flushing out the system, bacteriological samples are not satisfactory, repeat the disinfection process until satisfactory bacteriological samples can be obtained.

B. Disinfection of new supply mains shall be performed before these mains are connected to the existing water supply mains. Where connecting into the existing mains and it is not practical to include the connecting pieces (i.e., pipe, fittings, and valves) in the normal disinfecting process, these connecting pieces shall be swabbed with chlorine solution containing not less than 100 ppm available chlorine prior to making the connections.

3.3 WASTE VENT AND DRAINAGE

A. Use reducing fittings for changes in pipe size.

B. Fittings for waste, vent, and drainage piping to be drainage pattern type.

C. Soil, waste, and vent piping above ground shall be concealed in walls, chases, pipe shafts and ceiling spaces, except in equipment rooms and similar unfinished areas and elsewhere as specifically indicated otherwise. All soil and waste piping inside the building shall be run with a uniform drop of not less than 1/8" per foot, using ¼" per foot where possible.

D. Vertical vent lines shall be carried through the roof or connected to adjacent vent lines as indicated. Vents shall terminate approximately 12" above finished roof lines and shall be flashed with base and sleeve type into top of vent pipe. Collect vents where possible to minimize the number of vents extending through roof.

3.4 CLEANOUTS

A. Locate line size cleanouts, at base of each soil and waste stack; at each change in direction in soil, waste and drain lines; and in all horizontal drain lines, with spacing not to exceed 50' inside the building and 75' outside the building.

B. Cleanouts not accessible, which cannot be made easily accessible otherwise, shall be extended up through floor or wall.

3.5 ELECTRICAL GROUND

A. This Contractor shall make provisions for maintaining the electrical ground properties of water lines by strapping over valves or equipment whose removal for service work in future would break grounding service. Strapping over shall be done with a length of braided copper cable which shall be brazed to pipe at either end.

3.6 FIXTURE CONNECTIONS

A. Connect to plumbing fixtures and equipment provided under this and other sections of specifications.

B. See schedule on plans for connections sizes to fixtures.

C. Connect wall-hung urinals to waste piping with red brass nipples.

D. Each fixture, floor drain, and piece of equipment requiring connection to drainage system to have separate traps installed as close to fixture as possible.

E. Provide deep seal P-traps under floor drains.

3.7 CLEANING AND TESTING

A. Test plumbing systems in accordance with test procedures and pressure as specified in General Provisions.

B. Clean and sterilize domestic water supply in accordance with test procedures as specified in General Provisions.

END OF SECTION 22 08 00

SECTION 23 05 00 - COMMON WORK FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

A. It shall be the contractor's responsibility to furnish and install complete all systems, equipment, and related items described under Division 23.

B. It shall be the Contractor's responsibility to determine the characteristics of electrical currents available to operate the mechanical equipment prior to ordering such equipment. All electrically operated equipment shall be designed for operation with the type of electric current available to the project.

C. It shall further be the Contractor's responsibility to locate, layout and make provisions for all openings required in precast or cast in place concrete slabs, etc., necessary to accommodate his work.

D. Do all excavation and backfilling required for the installation of piping and other mechanical work underground. This work shall comply with all applicable provisions of "Excavating and Backfilling" and Section 02200, EARTHWORK.

E. Provide labor, materials, tools, and services for a complete installation of equipment and systems specified herein and indicated on drawings.

F. All equipment shall be installed in accordance with the manufacturer's drawings and recommendations.

G. The Contractor shall furnish and install all rough-in work and make final connections to all equipment requiring water, gas, drains, ductwork and other mechanical work required for connection to equipment furnished under this contract.

H. The equipment shall be properly prepared structurally and mechanically ready to receive a single connection for each of the various mechanical items with all plumbing, piping drains, traps, tailpieces, supply fittings, ductwork, gas lines, etc., internal to and part of the equipment installed by the equipment manufacturer or supplier.

I. Verify all connections and rough-in locations with the Architect and / or the equipment supplier or contractor prior to the start of their work.

J. Contractor agrees to assume responsibility for liability, workmanship and quality of materials concerning work sublet to others. Before part of contract is sublet, submit to Architect in writing names of proposed subcontractors and obtain written approval.

1.2 CODES AND FEES

A. All work shall be installed in accordance with the applicable provisions of the local codes, latest adopted International Mechanical Code, NFPA, AGA, UL, ASTM, ASHRAE, SMACNA, ASME and ANSI.

B. The Contractor shall pay for fees and inspections as may be required by agencies having jurisdiction.

1.3 ELECTRICAL WORK

A. All control wiring and conduit not shown on Electrical drawings shall be furnished and installed under Division 23 according to the National Electrical Code and Division 26 requirements. See G.2.

B. All power wiring and conduit for items furnished under Division 23 shall be furnished and installed under Division 26. See G.1.

C. All disconnects shall be furnished and installed by Division 26.

D. Toggle switches for 1/2 HP motors and less shall be furnished and installed by Division 26.

E. Wiring and conduit for solenoid valves, and control transformers including the transformers shall be furnished and installed by Division 23.

F. Division 26 shall install all starters, toggle switches, disconnects, and all wiring to the respective motor or device. Wiring and conduit from starter to a controller shall be by Division 23.

G. Definitions
   1. Power wiring: Line voltage circuitry rough-in including conduit, boxes, conductors, etc. between the overcurrent protection and the equipment including the connection of the starters.
   2. Control wiring: Any voltage circuitry rough-in including conduit, boxes, conductors, etc. between control activator and the controller or starter.

H. Conduit: All power wiring and 120V control wiring shall be in conduit. Low voltage control wiring shall be installed in conduit where exposed, or in return air plenums, in masonry walls, or below slab.

I. Smoke Detectors and Firestats
   1. Smoke detectors shall be furnished and installed by Division 23 unless the project has a fire alarm system, then smoke detectors shall be furnished by Division 26, installed in ductwork by Division 23. All wiring and conduit from detector to fan shall be considered control wiring. 110 Volt wiring to the detector shall be power wiring. Wiring from the detector to fire alarm system shall be furnished and installed by Division 26.

1.4 VISIT TO JOB SITE

A. Before submitting bid, Contractor shall visit the job site for the purpose of examining the site and conditions under which the work must be performed. No extra will be allowed for situations arising from failure of Contractor to thoroughly familiarize himself with site conditions.

1.5 RECORD DRAWINGS

A. The Contractor shall maintain a set of prints that reflect site conditions including location of valves, dampers, underground piping, ductwork, equipment, etc. that have been changed to suit job conditions. The contractor shall prepare a corrected reproducible tracing of the project using the results of the record print. Final payment shall not be made until such document(s) is turned over to the architect upon completion of the project.

1.6 QUALITY ASSURANCE

A. Perform work of this section using skilled workers who are trained and experienced in the required crafts and who are knowledgeable and familiar with the specified requirements and the methods to be used for proper performance of the work.

1.7 COMPLETE WORK

A. Contractor shall provide and install all systems in complete working order. All items normally required for operation shall be provided.

1.8 SEISMIC DESIGN

A. This project is located in seismic use Group 2, according to the International Building Code. All piping and equipment supports shall be installed according to Chapter 16 of the International Building Code.

B. Seismic restraints shall not be required for the following installations:
   1. Gas piping less than 1-inch inside diameter.
   2. Piping in boiler and mechanical rooms less than 1-1/4 inch inside diameter.
   3. All other piping less than 2-1/2 inch inside diameter.
   4. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the supporting structure.
   5. All ducts suspended by hangers 12 inch or less in length from the top of the duct to the supporting structure.
   6. Ducts which have a cross-sectional area less than 6 square feet.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

A. All pipe lines installed under the contract shall be clearly labeled to indicate their function and flow direction. Labels shall be applied by stencil, decal, printed tape, or equivalent method, and shall be so spaced that the lines may be traced from start to finish. Labels (where used) shall be Seton "Setmark" or approved substitute.

B. All starters and pushbutton stations shall be labeled to identify the equipment which they control, utilizing Kroy Duratype 240 SE industrial tape, and suitable labeling machine or approved substitute.

C. All air units, fans, etc., shall be labeled with drawing mark number and with description of area served, utilizing engraved plastic laminate nameplates. Nameplates shall be Seton “Setonply” or approved substitute.

D. All air unit thermostats shall be labeled with proper mark number identifying it with air unit it serves, utilizing Kroy Duratype.240 SE industrial tape, and suitable labeling machine or approved substitute.

E. Fire and smoke damper labels shall be placed on a tee bar below the damper. The label shall be the same size as described for valves and shall be marked FIRE DAMPER or SMOKE DAMPER.

2.2 INDOOR ENVIRONMENTAL QUALITY - LOW EMITTING MATERIALS

A. All adhesive and sealants used on the interior of the building (inside the weatherproofing and applied on-site) shall comply with “South Coast Air Quality Management District 9SCAQMD) Rule #1168", current VOC limits.

B. Paints and coatings used on the interior of the building shall comply with the following criteria for VOC limits:

1. Architectural paints, coatings and primers - Green Seal Standard GS-11, Paints, 1st Edition 5/20/93.
2. Anti-corrosive and anti-rust paints - 250 g/l per Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

2.03 SERVICE AND MAINTENANCE CONTRACT

A. The Contractor shall make arrangements with an independent service and maintenance contractor, “**other than the project mechanical contractor**” and as approved by the Architect, to perform all the required servicing and maintenance of the heating, ventilating and air conditioning system, without cost to the owner, for a period of one year after date of substantial completion. The name of the service contractor shall be part of submittals.

B. The servicing shall be complete in every respect and shall include but not be limited to the following: Replacing or washing of all filters as required for proper equipment operation, replacing bad belts, compressors, bearings, motors, controls, electric heaters, refrigerant specialties, couplings; cleaning drain pans and piping; replacing refrigerant and oil, bearing lubrication, and keeping equipment reasonably clean.

C. This service work shall be performed a minimum of three times a year. Filters may need changing more than 3 times depending on conditions. A written report shall be submitted to the Owner describing each visit. The date the service work starts shall be clearly identified in close out documents.

2.4 EQUIPMENT LIST, SHOP DRAWINGS AND SAMPLES

A. Submit to the Architect for approval, within 30 days after receipt of Notice to Proceed with the work, detailed shop drawings of all equipment and all material required to complete the project. The shop drawing shall be complete as described herein. The Contractor shall furnish the number of copies required by the General and Special Conditions of the Contract, but in no case less than six (6) copies.

B. **All shop drawings to be submitted at one time in a 3-ring binder with cover and drawing index sheet.**

C. The shop drawings shall be detailed, with dimensioned drawings or catalog cuts, showing construction, size, arrangement, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be a standard catalog product of an established manufacturer and of equivalent quality, finish, and durability to that specified. Submission material and all shop drawings for the various items of equipment shall be marked with the respective mark number or identification of the equipment shown on the drawing or in the specification.

D. Provide a cover sheet for all major equipment, shall list in detail all accessories called for in specifications and on drawings that are being supplied. Also, list operating capacities shown in schedules or described on drawings. Failure to list these items will result in resubmittal. A copy of a standard catalog will not be sufficient. Shop drawings for controls shall contain a detailed sequence of operation. Provide shop drawings for piping firestop details.

E. Shop drawings shall show sizes and details of required concrete and steel machine foundation, location of anchor bolts, physical dimension of equipment, equipment weight or other pertinent data required for equipment support or installation.

F. The contractor shall verify all electrical requirements of equipment with the electrical service available before ordering said equipment.

G. Approved shop drawings do not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings or specifications.

2.5 EQUIPMENT START-UP

A. Before final payment, provide architect and engineer with letter from each equipment supplier stating that equipment has been started and checked by factory qualified field service technicians and is installed and running satisfactory in every respect.

PART 3 - EXECUTION

3.1 TESTS

A. Test all piping, following installation, but before it is covered or connected to equipment. Furnish necessary labor, materials and equipment for making test. All leaks disclosed by testing shall be reworked in an approved manner and the leaking system shall then be retested until proved tight under pressure. Test all systems for watertightness (or gas-tightness) as required by the authorities having jurisdiction, or in the absence of such requirements the minimum tests shall be made as follows:

1. All refrigerant piping systems shall be tested at 200 pounds with dry nitrogen until all leaks have been made tight. After the pressure tests use suitable vacuum pump to evacuate the system to at least 1000 microns, then charge the system with refrigerant and oil as required. Prior to running the refrigerant equipment all safety and operating devices and controls shall be properly adjusted and tested for proper operation and protection of the equipment.
2. Test all gas piping systems with air or inert gas only. Test pressure shall be not less than five times the maximum pressure to which the piping will be subjected in operation for a period not less than 30 minutes.

B. Test all heating, cooling and ventilating equipment. When installation is complete, all equipment shall be tested for proper operation and functioning as directed by Architect.

1. All equipment, motors, fans, etc., shall run at their required speed and be free from excessive vibration and noise. No bearings, journals, or any part of the motors shall heat to a temperature in excess of 40°C. above the temperature of the surrounding air.
2. The equipment, diffusers, registers, dampers, etc., shall be adjusted to deliver air at all outlets according to the amount of air shown on the drawings or as required to obtain adequate room temperature.
3. Architect reserves the right to require the Contractor to demonstrate the uniformity of heating and cooling in each area of the building.

3.2 COORDINATION

A. The mechanical work shall be installed as neatly as possible in the locations shown but shall be subject to such deviations, modifications and relocations as may be necessary to conform to the requirements of the architectural drawings and as necessary to avoid interferences with the structural work and the work of other trades, and interferences between the various trades. This shall be done at no cost to the Owner. No ductwork or equipment shall be installed which would require ceilings to be lower than required by drawings, unless approval is obtained from the Architect.

B. It is the responsibility of the General Contractor to coordinate the work of his subcontractors. To this end, the General Contractor shall require that the various subcontractors carefully examine and familiarize themselves with the architectural and structural drawings and drawings covering the work of other trades, and that they frequently consult with all other trades so that the work may be coordinated.

C. If necessary to coordinate and expedite the work, the Contractor shall prepare "interference drawings" and submit them to the Architect for approval. Such drawings shall show the work of the various trades involved, illustrate proposed details of construction and arrangement of equipment and apparatus, and clearly indicate any deviations from contract requirements.

D. Minor changes in arrangement may be made to suit unforeseen conditions, but no major deviation shall be made without written approval from the Architect. If any deviations are deemed necessary, submit all details of proposed changes and all reasons therefore, in writing, to the Architect for approval prior to making installation of such work.

E. Do not fabricate ductwork before interferences are verified. No extra will be allowed for piping or ductwork fabricated in advance which can not be used.

F. Field verify exact sizes of fire dampers and duct balancing dampers before ordering. No extra will be allowed for dampers ordered in advance which can not be used.

3.3 EXCAVATING AND BACKFILLING

A. Do all excavating and backfilling required for the installation of underground work required by the mechanical work.

B. Excavating and backfilling shall comply with all applicable provisions of Section 02200 EARTHWORK, including the provisions therein concerning classification of excavated material.

C. Width of trench shall be not less than 18" wider than the pipe outside diameter. Minimum cover over top of water pipe shall not be less than 30". Minimum cover for other pipe shall be not less than 24".

D. Copper piping, PVC piping, and gas piping shall be laid on a 6" bed of sand and backfilled with 12" of sand in 6" layers to 12" above top of pipe in areas not below slab or pavement. Complete backfilling with Tennessee Highway Class "B" aggregate to slab under building and outside of building to underside of pavement. The balance of the fill outside the building shall be clean earth thoroughly tamped and crowned to allow for subsequent settlement. Compact to 100% density under buildings and paved areas.

E. All trenches shall be braced as required to protect workmen and adjacent work. Comply with local regulations or, in absence thereof, with provisions of the "Manual of Accident Prevention in Construction", of the AGC.

3.4 CUTTING AND REPAIRING

A. All chases, recesses, sleeves and other openings in masonry and concrete shall be built in as the construction work progresses, and it shall be the responsibility of the subcontractor to see that such chases, recesses, sleeves and other openings required for their work are properly located and installed. If this is not done by the subcontractor whose work required such accommodation, it shall be performed at his expense.

B. Structural members or finished work shall not be cut without the express permission of the Architect. Cutting shall be done neatly and patching or repairing shall match adjacent work.

3.5 PROTECTION AND CLEANING

A. Work shall be protected at all times. Pipe openings shall be closed with caps or plugs until permanent connections are made. Equipment shall be covered, if necessary, to protect against dirt, water, chemical or mechanical damage or defacement. Cover all machine openings and open ends of ductwork to prevent entry of dirt and debris as project construction progresses.

B. Upon completion of the work and after all tests have been made and piping systems proven tight, clean all equipment, traps, dirt pockets, water tanks, circulating systems, filters, etc., and leave in correct operating condition. No air unit shall be operated without filters.

3.6 PAINTING

A. Painting of mechanical equipment, piping, and exposed ductwork in finished spaces, or exposed on the exterior, shall be finished as specified under Section 09900, PAINTING. All equipment exposed on the exterior furnished without factory finish shall be painted.

B. Equipment with a factory applied finish shall have scratches, chips, etc., primed and touched up with materials which will protect the surface and match the adjacent area.

3.7 OPERATING INSTRUCTIONS

A. Furnish the services of competent personnel to instruct the Owner's personnel in the proper operation and maintenance of all equipment, for a period of not less than 3 working days. All owner training sessions shall be video taped and at the completion of training a DVD format copy of the video shall be given to the owner with all installation, operation, and maintenance manuals.

B. Furnish and deliver to the Owner three sets of operating instructions for all equipment installed under this contract, including shop drawings, piping diagrams, wiring diagrams, maintenance recommendations and information concerning replacement parts. This information must contain mechanical and plumbing contractor names, equipment supplier names, contact personnel, telephone numbers, and facsimile telephone numbers. This information shall be contained in a three ring binder of suitable size, and labeled on the exterior with project name.

3.8 QUIETNESS OF OPERATION

A. All fans, motors and other apparatus shall be selected and installed for reasonably quiet operation. Any objectionable noise which develops shall be corrected before the work will be accepted. Equipment or duct connections and fittings which produces objectionable noise shall be adjusted or insulated so as to eliminate the noise, or shall be removed and replaced by satisfactory equipment. Provide spring or rubber machine mounting isolators and flexible piping and duct connections where necessary to prevent transmission of vibration to building structure or to piping and duct system.

3.9 GUARANTEE

A. The Contractor shall guarantee all work to be in accordance with contract requirements and free from defective or inferior materials, equipment, and workmanship for a period of one year, and he shall guarantee that all equipment is of proper size and design and so installed as to produce the capacities and results specified and shown on the drawings. Compressors shall have an extended 4 year warranty.

3.10 SUBSTITUTIONS

A. Substitutions shall be allowed in accordance with Division 1. Substitution approval shall be at the sole discretion of the Engineer.

B. Contractor shall note on shop drawings all major differences from specified material or equipment.

C. When making requests for substitutions, Contractor assumes the following responsibilities:

1. To have personally investigated the proposed substitute product and determined it is equal or superior in all respects to that specified;
2. To provide the same warranty for substitute that Contractor would for that specified:

3. To provide complete cost data, and waive all claims for additional costs related to substitution, which subsequently become apparent; and
4. To coordinate installation of the accepted substitute, making such changes as may be required for Work to be complete in all respects.

D. All requests for substitution must be submitted to the architect and engineer a minimum of 14 calendar days prior to project bid date. Such submission does not constitute approval. Only items or manufacturers specifically stated in the project specifications, drawings or addenda for use shall be considered as approved.

END OF SECTION 23 05 00

SECTION 23 05 10 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General provisions of Division 15, General and Supplementary Conditions, and General Requirements of Division 1, apply to this section.

1.2 BASIC REQUIREMENTS

A. Equipment and materials used in the work shall be in accordance with the contract documents, of the best quality and grade for use intended, shall be new and unused and shall be the manufacturer's latest standard or current model for which replacement parts are readily available.

B. Work shall be installed under the constant supervision of a competent superintendent and by skilled and competent mechanics experienced in the trade that contractor is practicing.

C. All apparatus and equipment shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations. All auxiliary piping, water seals, valves, electrical connections, etc., recommended by the manufacturer or required for proper operation shall be furnished and installed complete.

D. The work of this section is subject to the requirements of the Mechanical General Provisions and the General Provisions in Division 1.

PART 2 - PRODUCTS

2.1 SLEEVES AND PLATES

A. All pipes that pass through masonry partitions and walls and concrete floor slabs shall be installed with standard weight galvanized steel sleeves. Sleeves through floors shall be long enough to project a minimum of 2" above finished floor. Sleeves shall be large enough for pipe, pipe insulation and required fire caulking. Sleeves in concrete shall be accurately located in the forms and secured in place to prevent displacement during pouring of concrete. Sleeves below grade in exterior walls shall be Link-Seal with wall penetration seal or approved substitution.

B. Sleeves in finished spaces shall finish flush with the finished wall surface. Sleeves for insulated water or refrigerant pipe shall be large enough to accommodate the insulation.

C. Pipes passing through masonry walls and partitions in finished spaces shall be fitted with metal escutcheons or collar plates. Plates occurring in painted walls or ceiling shall be prime coated for painting; other plates shall be chromium plated.

D. Exposed ducts passing through finished walls shall be furnished with sheet metal escutcheons.

E. All pipe penetrations of fire rated floors or walls are to be protected. Space between metal pipe and wall or sleeve shall be protected with Hilti Fire Barrier Penetration Sealing System or approved substitute. Installation shall be in accordance with the manufacturers recommendations for the hourly fire rating of the partition. The system shall be U.L. listed. For insulated chilled water, domestic cold water and refrigerant pipe, continue insulation and vapor barrier through wall. The sleeve through the wall shall be large enough for the pipe, insulation and fire caulking.

F. PVC pipe passing through rated walls, ceilings or floors shall have Hilti UL Listed Fire Protection System or approved substitute. System number shall be as required by construction and rating.

2.2 ACCESS PANELS

A. Furnish steel access panels, not smaller than 12" for single valve and 12" X 24" or 18" X 18" for two or more valves, for access of concealed valves, unions, dampers, etc., where no other means of access is shown or specified. Access panels shall be turned over to the general contractor for installation.

B. Panels shall be Milcor, or approved substitute, with screw driver operated cam latch, and of proper design and style for installation in wall, floor or ceiling construction called for on architectural drawings. Access panels in fire rated construction shall have a UL label Class B rating. All panel styles to be verified by the Designer.

2.3 MOTORS

A. Motors shall be in accordance with AIEE, UL, and NEMA standards selected for quiet operation, of standard design for specific voltage available, and for continuous duty 40°C. rise. Unless otherwise specified, they shall be open drip proof, ball bearing, squirrel cage type, equal to Louis Allis, Westinghouse, G. E., or approved substitute. Provide raceway terminal box on each motor, of ample size and with removable cover for connections.

B. Motors up to and including l/2 HP shall be designed for 120 volts, single-phase current; motors 3/4 HP and larger shall be designed for 3-phase current. Voltage will be as called for on the drawings. Verify characteristics of available current at the building before equipment is ordered. Verify with electric drawings.

C. Horsepower for all motors shall be such that when drive apparatus is operated at full capacity, motor shall be under not less than 3/4 load nor more than full rating.

D. Each motor shall have a permanent name plate, showing name of manufacturer model and serial numbers, amperes per phase, horsepower, voltage, speed and cycles.

E. Provide for each belt drive motor a guard shielding perimeter and face of the drive.

2.4 MOTOR CONTROLS

A. All motors shall be furnished with starters under Division 23.

B. Manual starters with overload protection shall be used to control motors 1/2 HP and smaller. Single phase motors requiring interlock and all 3-phase motors shall be provided with magnetic starters.

C. Magnetic starters shall have thermal overload and low voltage protection. Three phase starters shall have (3) thermal overloads. Also, provide ground fault protection. All electrical and mechanical components shall be of the highest quality, and parts subject to wear or deterioration shall be renewable. Starters for motors 3/4 HP and larger shall be combination fused type and incorporate type L.P.S. fuses. Holding coils shall suit the requirements of control diagrams. Provide control voltage transformers in starters as indicated on control diagrams. Starters to be UL listed.

PART 3 - EXECUTION

3.1 GENERAL

A. Run exposed ducts and piping parallel to the principal parts of the building. Ducts and piping shall be run concealed when provisions are made in floors, walls, ceilings and chases through all finished spaces, except at fixture connections and where specifically noted otherwise. Do not run water pipe below ground floor slab except where necessary.

B. Piping, ducts, and equipment shall be kept as close as possible to ceilings, walls, columns, etc., and shall be installed in such an orderly manner as to take up a minimum of space and allow a maximum of headroom, and all offsets, fittings, etc., required to accomplish this shall be furnished and installed, whether or not each offset and fitting is specifically shown or noted. Minimum clearances on exposed piping shall be maintained as specified under "Piping Clearances" herein.

END OF SECTION 23 05 10

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTALS

A. Qualification Data: Submit evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.2 QUALITY ASSURANCE

A. Work required under this section shall comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), National Environmental Balancing Bureau (NEBB) or Associated Air Balance Councils (AABC), Recommendations Pertaining to Measure, Instruments, and Testing, Adjusting and Balancing by Certified technicians.

B. The mechanical contractor shall make arrangements with an independent balancing agency to balance all air and water flows to the rates indicated on the contract drawings and schedules. This shall include supply fans, exhaust fans, air handling systems, pumps and waterflows. The balancing agency shall be one normally engaged in such work and **shall be either AABC or NEBB Certified**. Test and balance reports not prepared by an AABC or NEBB certified contractor will be rejected and the complete system shall be retested by an AABC or NEBB certified contractor at no cost to the owner. All test and balance reports shall be certified per AABC or NEBB.

C. The mechanical contractor shall submit a complete resume of the balancing agency for approval by the architect and engineer prior to beginning any work. The resume shall contain examples of previous projects, references, personnel available, certifications and test and balancing report format.

D. TAB Report Forms: Use standard forms from:
   1. AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
   2. NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
   3. SMACNA's TAB "HVAC Systems - Testing, Adjusting, and Balancing."
   4. TAB firm's forms approved by Architect.

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.3 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed. The work required under this section includes all work necessary for the proper testing, adjusting and balancing of all air and water systems to achieve the results specified by the contract drawings and specifications.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. Except as otherwise indicated, use same products as used by original installer for patching holes in insulation, ductwork, and housing which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes. At technician's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housing. Leave no test holes or access openings uncovered and insure vapor barrier continuity of all insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB fieldwork shall not begin on any system / equipment item until signed Pre-functional checklists (PCs), pertaining to applicable equipment, have been submitted by the installing contractor to the Commissioning team.

3.2 PRE-TAB INSPECTION AND REPORT

A. Prior to the start of any test and balancing work, a representative of the test and balancing agency shall visit the project for the purpose of inspecting the work in place, and shall prepare and submit a written report to the mechanical contractor and engineer stating work which is to be completed before testing and balancing can proceed. Copies of the TAB agency generated deficiency reports shall be submitted to the Architect.

B. The contractor shall schedule a pre-TAB conference with the TAB representative, Owner, Architect and Engineer to review the report prior to start of TAB Work.

C. No retesting of submitted deficiency items should be attempted by the TAB agency until signed copies of the deficiency reports, certifying completion of the item, have been received back from the applicable installing contractor. Failure to do this will render the test and balance report null and void. If the report is deemed null and void, all testing must be performed again at no additional cost to the owner, in the presence of the architect and/or engineer.

3.3 TESTING, ADJUSTING AND BALANCING REPORT

A. Preliminary copies of the final TAB report shall be made available to the Commissioning team at the completion of the TAB fieldwork for the TAB performance verification phase of the Commissioning procedures

B. The testing and balancing agency shall record the test results in tabulated formats for both cooling and heating conditions, and shall submit a minimum of three copies to the architect for review and approval. A copy of the completed and approved report shall be placed in each copy of the facility operating and maintenance manuals.

3.4 AIR BALANCING

A. The air balance shall include the following air tests in accordance with the following requirements. Test all air systems with new, clean filters in place.
   1. Test and record fan total CFM (design and actual)
   2. Test and record fan outside air CFM (design & actual)
   3. Test and record fan suction static pressure and fan discharge static pressure (actual)
   4. Test and record static pressure on both sides of all filters and coils (actual)
   5. Test and record fan RPM (design and actual)
   6. Record fan sheave, motor sheave, pitch diameter after adjustment (if variable), center line to center line distance from fan shaft to motor shaft, belt size, and number of belts (actual)
   7. Change sheaves, pulleys, and belts, if required to obtain design air flow.
   8. Test and record fan motor horsepower, amperage, voltage, and RPM (rated and actual)
   9. Record fan motor manufacturer, model and serial numbers and service factor (actual)
   10. Record motor starter size (actual)
   11. Test and record diffuser, register and grille CFM (preliminary, design and actual) for supply, return and exhaust systems. If the return air quantities are not shown at the return grille locations on the contract documents, use the percentage method (supply air less the outside air equals the percentage of return air) and balance the return air grilles accordingly.
   12. Test and record main duct traverse readings for all air handling units and fans (preliminary, design and actual). This shall include exhaust, supply, return and outside air ducts.

13. Record each air handling unit supply air temperature; return air temperature; mixed air temperature and outside air temperature (dry bulb and wet bulb) in heating and cooling modes.
14. Record air temperature and humidity in each room at time of air balance.
15. Record AHU type, location, manufacturer, model number, and serial number.
16. Mark all damper quadrants as to final adjusted position, and lock into place.
17. Check fan rotation on all fan units.
18. Check filters for cleanliness prior to balancing. Test only with new, clean filters of the type specified in place.
19. In cooperation with the control manufacturer's representatives, set and adjust all automatically operated dampers to operate as specified.
20. Record the date, time, outside temperature and outside humidity at the time of recording unit temperatures.

3.5 WATER BALANCING

A. The water balancing shall include the following tests in accordance with the following requirements.
   1. Check all pump rotations.
   2. Check expansion tank to insure system is full of fluid. Record setting of makeup water pressure reducing valve.
   3. Check all air vents at all high points of hydronic system to insure that all air is removed from the circulating system.
   4. Each cooling and heating coil including reheat coils, shall be tested for total performance. All coils shall be tested with the design air and water flows through the coil and tests shall not be performed at less than 80% of design load. Any imposed loads must be fully documented in the report.
   5. Each heat exchange shall be checked and set for flow , pressure drop and temperature rise.
   6. Check and clean all strainers specified for the system. Verify that construction strainers have been removed from pumps.
   7. Insure that all gauges and thermometers are installed and easily readable, and that sight glass on system on expansion tank is easily readable.
   8. Lock and mark all balancing valves and to final adjusted position.
   9. Open all shut-off balancing and control values. Close all bypass values. Test and record pressure differential across pumps.
   10. Adjust and record balancing valves to obtain design pump head.
   11. Test and record pump motor full load amperes, voltage RPM, and horsepower. (Rated and actual)
   12. Test and record flow and pressure across each water source heat pump.
   13. Test and record entering and leaving fluid temperatures at coils with system operating at maximum flow.
   14. Adjust all coil bypass valves.

3.6 STEAM BALANCING

A. TESTING TOLERANCES
   1. Air and water balancing shall be within plus/minus 5% for all:
      a. Air Units
      b. Supply Fans
      c. Exhaust Fans
      d. Grilles and Registers
      e. Waterflows

END OF SECTION 23 05 93

SECTION 23 07 00 - INSULATION - HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, General and Supplementary Conditions, and General Requirements, apply to this section.

1.2 WORK INCLUDED

A. Work required under this section consists of insulation for piping and duct systems and equipment as hereinafter specified.

B. The work of this section is subject to the requirements of the Mechanical General Provisions and Basic Material Specifications.

1.3 BASIC REQUIREMENTS

A. All materials used for insulation of pipe and ducts and equipment covered in this section shall be UL listed. Fire hazard ratings shall be as follows:

1. Flame spread of 25, and smoke development of 50 for all duct insulation and other insulation located in ceiling plenums or rooms utilized for return air plenums.
2. Flame spread of 25 and smoke development of 200 for other pipe and equipment insulation.

B. Increase the insulation thickness of ½" on all piping outside the building insulation envelope and weatherproof with 0.016" thick aluminum jacket with aluminum fitting covers. This piping shall be protected with electric heat tape installed under the insulation.

C. All insulation and thicknesses are selected to meet the 2012 International Energy Conservation Code.

D. Install 0.016" thick aluminum jacket on all pipe insulation in mechanical rooms 7'-0" from finished floor.

PART 2 - PRODUCTS

2.1 FLEXIBLE TUBULAR ELASTOMERIC

A. Provide fire-retardant closed-cell slip-on flexible type. Product must be guaranteed by manufacturer to have continuous operational temperature limit of not less than 180°F and a minimum "R" value of 3.57 at 75°F 50% RH. Provide insulation for the following:

1. Expansion tanks and air separators, 1½" thick.
2. Pump casings, 1" thick.
3. Refrigerant suction and hot gas bypass lines - ½" thick on lines 1" or less - 1" thick on lines larger than 1". Install a 0.016" thick aluminum jacket on insulation outside the building.

2.2 FLEXIBLE SHEET ELASTOMERIC

A. Provide fire retardant closed-cell flexible type. Product must be guaranteed by manufacturer to have continuous operational temperature limit of not less than 180°F, and a minimum "R" value of 3.57 at 75°F, 50% R.H. Provide insulation for the following:

B.

1. Pump casings - 1" thick.
2. Expansion tanks and air separators - 1-1/2" thick.

2.3 FIBERGLASS FOR PIPE

A. Provide 4-pound density 500°F snap-on type glass fiber with factory applied Owens Corning Paper Free ASJ Jacket and SSL II Closure System with vapor barrier. Fitting, including ells, valves and tees, shall be insulated with snap-on preformed insulation the same thickness as pipe insulation and finished with glass fabric and vapor barrier mastic. Use foam glass half sections at hanger saddle on pipe sizes 2" and larger to eliminate insulation deformation. Insulation to have a minimum "K" value of 0.23 @ 75°F mean temperature. Provide this insulation for the following:

1. Geothermal circulating water supply and return lines - 1" on pipe size up to 1½", and 1½" thick on pipe size 2" and larger. Expansion tanks and air separators - 1" thick.

2.4 FIBERGLASS BLANKET FOR DUCTS

A. Provide 2" thick 3/4" lb. density fiberglass blanket insulation with FSK or FRK jacket installed "R" value of 5.6. Install according to manufacturer's recommendations. For ducts 30" wide and over support insulation on bottom of duct with rows of welded insulpins on 18" center. Lap jacket 2" at seams and vapor seal. Provide this insulation for the following:

1. All supply air ducts. Supply ducts exposed in conditioned spaces do not require external insulation.
2. Outside air ducts.
3. Top of supply air diffusers.
4. Return air ducts installed below building insulation shall <u>not</u> be insulated unless noted otherwise.
5. Relief air ducts and grilles.
6. Supply and return duct insulation in attic spaces above roof insulation shall be 3"- 3/4# density with installer "R" value of 8.3.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all insulation products in strict accordance with manufacturer's instructions.

B. All items requiring service such as strainers, balancing valves, etc., provide removable insulation caps of insulation equal in thickness to pipe covering.

C. Cover all joint, rips, tears, punctures, staples, insulpins or breaks in vapor barrier jacket with 4" wide woven glass fabric tape embedded in vapor barrier fire resistant mastic.

D. No insulation shall be cut where a hanger is located.

E. Flexible tubular elastomeric piping installation shall be as follows:

1. Install pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be adhered and sealed using Armstrong 520 Adhesive. When using AP Armaflex SS only the butt joints shall be adhered using 520 Adhesive.
2. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints.
3. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives must be used.
4. On cold piping, insulation shall be adhered directly to the piping at the high end of the run using a one inch strip of 520 Adhesive on the ID of the insulation and on the pipe. All exposed end cuts of the insulation shall be coated with 520 Adhesive.
5. Sheet insulation shall be used on all pipes larger than 6" IPS. Insulation shall not be stretched around the pipe. On pipes larger than 12" IPS, adhere insulation directly to the pipe on the lower 1/3 of the pipe.
6. Seams shall be staggered when applying multiple layers of insulation.
7. All fittings shall be insulated with the same insulation thickness as the adjacent piping. All seams and mitered joints shall be adhered with 520 Adhesive. Screwed fittings shall be sleeved and adhered with a minimum one inch overlap onto the adjacent insulation.
8. Valves, flanges, strainers and couplings shall be insulated using Armaflex donuts that shall then be covered with sheet or oversized tubular insulation.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 91 13 – General Commissioning Requirements

C. Section 22 08 00 – Commissioning of Plumbing Systems

D. Section 26 08 00 – Commissioning of Electrical Systems

1.2 COMMISSIONED SYSTEMS

A. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning verifies that systems are operating in a manner consistent with the Contract Documents.

B. Refer to Part 3 of this section for a detailed list of equipment included in each commissioning activity.

1.3 RESPONSIBILITIES

A. The Contractor shall be responsible for scheduling, supervising and performing start-up, testing and commissioning activities specified in this section and necessary to demonstrate to the Owner successful operation of the commissioned systems.

PART 2 - PRODUCTS

2.1 MEANS OF ACCESS

A. The Contractor shall provide means for the CxA to access, observe and visually confirm proper operation of all equipment and systems. These means shall be in compliance with all OSHA and job-site safety regulations.

2.2 TEST EQUIPMENT

A. The Contractor shall provide the necessary equipment to fully test the commissioned systems as defined in the functional performance test procedures to be provided by the CxA.

PART 3 - EXECUTION

3.1 EQUIPMENT PRE-FUNCTIONAL CHECKLISTS

A. Equipment installation checklists, provided by the CxA, shall be completed by the Contractor on the following systems:
   1. Chilled Water / Condenser Water Pumps
   2. Plate & Frame Heat Exchanger
   3. Dedicated Outdoor Air Rooftop Unit
   4. Cooling Tower
   5. (Ground Source Heat Pumps
   6. Geothermal Bore Field Well
   7. Smoke Exhaust Fans
   8. Kitchen Exhaust Fan
   9. Kitchen Makeup Hood
   10. Split Systems

3.2 FUNCTIONAL PERFORMANCE TESTS

A. The Contractor shall provide all documentation as requested to the CxA for development of functional performance testing procedures. This documentation shall include, at a minimum, manufacturer installation, start-up, operation and maintenance procedures. The CxA may request further documentation as necessary for the development of functional performance tests.

B. Functional performance tests shall be performed on the following systems (sampling rates are indicated in parenthesis, assume these to be 100% unless noted otherwise):
   1. (4) Chilled Water / Condenser Water Pumps
   2. (1) Plate & Frame Heat Exchanger
   3. (1) Dedicated Outdoor Air Rooftop Unit
   4. (1) Cooling Tower
   5. (28) Ground Source Heat Pumps
   6. (1) Geothermal Bore Field Well
   7. (4) Smoke Exhaust Fans
   8. (1) Kitchen Exhaust Fan
   9. (1) Kitchen Makeup Hood
   10. (4) Split Systems

C. The sampling rates shown above are to be considered a minimum. The contractor is expected to perform functional testing on 100% of commissioned equipment but no less than shown above.

D. The Contractor shall review the functional performance test procedures developed by the CxA.
   1. The Contractor shall respond in writing to the CxA regarding the acceptability of the proposed test procedures.
   2. The Contractor shall note any necessary modifications to the procedures due to the actual equipment/systems or safety concerns and shall submit these to the CxA for consideration.

E. The Contractor shall place equipment and systems into operation and continue the operation as required during each working day of the testing activities.

F. The Contractor shall accomplish the functional performance testing of equipment based on procedures developed by the CxA and as reviewed by the Contractor.
   1. The Contractor shall provide skilled technicians to operate the systems during functional performance testing. At a minimum, the contractor should provide one trade technician familiar with the system being tested and one controls technician to operate the system through the BAS.
   2. The Contractor shall correct any deficiencies identified during testing and retest equipment as required.

G. Functional performance testing is intended to begin upon completion of a system. Functional performance testing may proceed prior to the completion of the system at the discretion of the CxA and the Contractor.

H. Functional testing shall verify all sequences of operation defined in the Contract Documents for the commissioned equipment and systems.
   1. Testing shall occur by overriding setpoints or sensor readings at the BAS or by other means mutually agreed to by the Contractor, the CxA, and the Owner to initiate sequences of operation and verifying the response of the system.
   2. Sequences of operation shall be verified under normal power, emergency power, and fire alarm scenarios.

I. Upon successful completion of all functional performance tests, the Contractor(s) shall perform Integrated Systems Testing. The testing shall document and verify the proper response of all Division 23 systems to all potential utility and emergency power operating and failure scenarios.

3.3 DEFERRED FUNCTIONAL PERFORMANCE TESTING

A. The Contractor shall perform any deferred testing as required to properly demonstrate successful operation to the Owner.
   1. Some test conditions may not be able to be simulated and thus require these actual conditions to be present to implement the test.
   2. A mutually convenient time to the Owner, CxA and Contractor will be scheduled when these test conditions will be present to conduct this deferred testing.

B. The Contractor shall perform these tests as indicated in the functional performance test procedures.

C. The Contractor shall correct any deficiencies or failures identified in the process of performing these tests.

END OF SECTION 23 08 00

SECTION 23 09 00 - CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Building Management System Contractor (BMSC) shall provide all components and all work associated with the Building Management System (BMS) including but not limited to: conduit" cabling, wiring, field devices, enclosures, control panels, Cisco manufactured Ethernet managed switch, switch panels" True equal BACnet/I/P Ethernet node connected, fully standalone, fully field programmable, full self contained resident real time clock residing present with controller equipment level direct digital controllers, Tridium Niagara AX Framework True Open To All server software including all application programs and full top of line functionality, Tridium Niagara AX Framework True Open To All server and client workstation including all application programs and full top of line functionality, applications and technical services for an Owner provided IPAD, full top of line software, full top of line programs, full top of line data information storage, transfer and archiving, full top of line display graphics, full top of line dynamic trend graphics, full top of line reports, full top of line record trend graphs, full top of line record reports, full top of line graphical user interfaces, full top of line remote alarming email services, full top of line remote user full operation over internet through Owner provided Sonicwall router firewall, full top of line data archiving, full top of line integration of data from legacy Teletrol TSC controllers as defined in Alternate Scope for this project through Owner provided legacy systems to BACnetilP gateways, over through to the new True Open To All Tridium enterprise level Java Application Control Engines (JACEs) controllers tagged NC for this project, all engineering, all programming, all technical services, and all other items and work to cause a complete, properly operating fully functioning BMS in the sole opinion of the Owner and Engineer.

B. BMSC shall provide a BMS which provides full integration in/out of all information from all building equipment level equal Ethernet node connected BACnet/I/P operating DOC controllers tagged as "(EC)" to the network of True Open To All Tridium JACE Network Controllers tagged ("NC'? as shown on the Plans. The BMS enterprise level shall be True Open To All Tridium Niagara AX Framework platform including, but not limited to:
   1. Tridium AX WEB Supervisor
   2. Tridium Workbench
   3. Tridium Supervisor
   4. Tridium JACE 700 True Open To All Network Controllers, without any OEM key functions which restrict the Owners use of any BMS portion, without any proprietary provisions, and without any Owner use restrictions.

C. BMSC shall provide a BMS which provides building control and monitoring out from the True Open Tridium JACE Network Controllers (NC) to the HVAC systems shown on the Plans using True Native BACnet/I/P equal Ethernet node connected based DOC controllers (EC), True Native BACnet/I/P software and True Native BACnetllP components and methods. The BMS Building Equipment Direct Digital Controllers (EC) shall:
   1. Communicate with all building controllers using BACnet/I/P protocol
   2. Operate as an equal node on a building wide intranet Ethernet 100MB LAN
   3. Be BACnet Testing Lab (BTL) listed and certified with Protocol Implementation Compliance (PIC) statements.

D. BMSC shall provide a BMS which provides full integration in/out of all information and portions as required by Owner or Engineer from I to the Variable Frequency Drives using BACnet/I/P protocol.

   This specification protects the Owner from an OEM Contractor installing proprietary Tridium AX workstation software, which they purchase from Tridium with a software "lock" which allows them only to access all the configuration functions. These Contractors also sell OEM JACE controllers, which should be avoided at all costs, because they too have proprietary software locks in the OEM version. It also sets the campus network communication protocol (BACnet IP), which is determined by the Owner at the outset of the design process. BACnet IP is the newest, most common protocol, used for these types of systems today, but you may run into equipment (chillers, power meters, HW heaters, etc.) that will have either MOD BUS or LON as the only options for communication. The Engineer-of-Record will need to specify this in detail in the contract documents.

   This non-proprietary software and the JACE controllers can only be purchased from a full Tridium reseller, but not any of the manufacturer OEM versions of Tridium. Fortunately, a customer (or the selected Controls Contractor for the project) can buy this software and the controllers from ANY Tridium full reseller in the nation; they have no "territories" like most of the Controls manufacturers (e.g., Johnson, Trane, Siemens). The Owner actually OWNS the software lock in the non-proprietary version and would give this to the selected Controls Contractor on future projects.

   This next section covers the BACnet IP network itself, and is specified as a completely standalone network, separate from the Campus Ethernet Network (data network).

E. Controllers, network, and BMSC shall utilize same programming language for application including implementation of control algorithms, alarms, and pseudo points. Provide all software tools to Owner for Owner use in field programming of network controllers and HVAC equipment direct digital controllers. This software shall be the property of the Owner, and the Owner shall not be required to use the BMSC to do any software work past the warranty period.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. The manufacturer shall provide response to problem or warranty requests within 24 hours of contact during the two year warranty period.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate variable speed drives and damper/valve actuators with equipment suppliers. All actuators shall be by the controls company.

C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

1.4 WARRANTY

A. Complete control system shall have a full two (2) year parts and labor warranty. Warranty shall commence upon substantial completion.

PART 2 - PRODUCTS

2.1 NETWORKING

A. Local Area Network:
1. Workstations, True Open JACE 700 Network Controllers (NC), Cisco managed Ethernet switches (SW), and all fully standalone, fully field programmable True Native BACnet IiP based Direct Digital Controllers (EC).
2. Workstations and JACE Network Controllers (NC) shall directly reside on a dedicated CA T 6 hard wired Ethernet 100MB network such that communications may be executed directly between all controllers and workstations without relying on Owner's IT Ethernet network.
3. Building Equipment Direct Digital Controllers (EC) shall directly reside on a dedicated Ethernet 100MB network such that communications may be executed directly between all direct digital controllers without relying on Owner's IT Ethernet net-work. All direct digital controllers shall be equal nodes on its dedicated intranet Ethernet 100MB LAN.
4. The BMS network shall be tied in to Owner IT network through the existing Owner provided firewall Sonicwall router located in the Building

Management system Operations Interface Station (BMSOIS) located on Level P1 in the Capitol Extension.

5. The Ethernet switches used in the BMS shall be managed switches manufactured by Cisco, in varying port quantity for each location which provide 25% spare ports in addition to required connections per location.
6. Network design shall include the following provisions:
   a. Data transfer for alarm reporting, report generation from multiple controllers, and upload/download efficiency between network devices.
   b. Support of any combination of controllers, workstations and laptops directly connected to network.
   c. Detection and accommodation of single or multiple failures of controllers, or other components. Network shall include provisions for automatically recon-figuring itself to allow operations to perform their designated functions in the event of single or multiple failures.
   d. Message and alarm buffering to prevent information from being lost.
   e. Error detection, correction, and retransmission to guarantee data integrity.
   f. Provide automatic synchronization of real time to all controllers.
   g. Data transfer for all portions from multiple controllers, and upload/download efficiency between network devices.
   h. Message and alarm buffering to prevent information from being lost.
   i. Error detection, correction, and retransmission to guarantee data integrity.
   j. Provide automatic synchronization of real time to all controllers.

We recommend that the Controls network be kept separate from the Campus "back-bone" Ethernet network, to avoid "conflicts" between the systems, and the Campus IT and Maintenance departments. In this design the buildings would be connected via a fiber network, installed in the same trenches, piping, as the Campus Ethernet network, and our last customer, just specified the Controls network fiber a different color from the Campus back-bone, for ID purposes (they chose purple for controls, orange for Campus back-bone).

This next section covers the hardware specs and manufacturer configuration software for the local controllers selected. This configuration software is sometimes known as controller "Tools".

This would also apply to the equipment specification for chillers, VFDs, etc., but be careful to put this in each equipment specification, if Tridium communication is desired, as the Equipment Vendors rarely, refer to the Controls specification, when they bid to the installing Contractors, they only comply with their "section" (the equipment specification section) of the contract documents.

2.2 DDC EQUIPMENT

A. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
2. Processor: Intel Pentium 4.
3. Random-Access Memory: 4GIG.
4. Graphics: Video adapter, minimum 800 x 600 pixels.
5. Monitor: 17 inches LCD color.
6. Keyboard: QWERTY 105 keys in ergonomic shape.
7. Hard-Disk Drive: 800 G.
8. CD-ROM Read/Write Drive: 48x24x48.
9. Pointing Device: Touch pad or other internal device.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
   d. Software applications, scheduling, and alarm processing.
   e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
3. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   d. Remote communications.
   e. Maintenance management.
   f. Units of Measure: Inch-pound and SI (metric).
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol or approved substitute protocol.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status.

Functions include the following:
a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 BUILDING EQUIPMENT DIRECT DIGITAL CONTROLLERS (BEDDC)

A. Controller shall be True Native BACnet and possess BACnet Testing Lab PIC statement

B. Controller shall be fully standalone and fully field programmable.

C. Controller shall have all programming and memory resident in controller required to perform according to statements made in other portions of this specification.

D. Controller shall have on board real time clock

E. Training in the amount of 40 hours occurring in (10) sessions of (4) hours duration on site over a 30-day period shall be provided for four SPB technical staff personnel, as part of scope of this project. BMSC shall present the training plan and outline with its proposal.

The following statement requires that the Local Controller manufacturer provide all configuration, operation and maintenance software necessary to operate and modify the local equipment controller, up to and including database saves over the BACnet IP network to the Tridium AX workstation (this would become the "archive" server for the system). Without these tools the customer would be in a proprietary situation, as he could not modify or manipulate the actual local controller point database. Tridium has a really nice feature, in that, one can configure the "tools" to operate within the Tridium AX system as a macro, accessible by a configured macro, or navigation "button" right on the Tridium graphic for the equipment, while the Tridium system is running, "one stop shopping" for the Operator.

2.4 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Exposed.
5. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:
1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: use where prone to temperature stratification or where ducts are larger than 9 sq. ft. length as required.

5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Exposed.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

D. Pressure Transmitters/Transducers:
1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg
   d. Duct Static-Pressure Range: 0- to 5-inch wg
2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.5 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.6 GAS DETECTION EQUIPMENT

A. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

2.7 AIRFLOW MEASURING STATIONS

A. Duct Airflow Station: Multi-point electronic thermistor probe suitable for duct or fan inlet air flow measurement with transmitter.
   1. Acceptable Manufacturers:
      a. Ebtron Gold Series
   2. Casing: Aluminum alloy.
   3. Accuracy/Repeatability: ± 2% / ± 0.25%.
   4. Transmitter: UL Listed

2.8 THERMOSTATS

A. Electronic, microcomputer-based room thermostats shall be provided in all rooms as follows.
   1. Setpoint adjustment with scales graduated in degrees ºF.
   2. Override button.

2.9 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Acceptable Manufacturers:
      a. Belimo Aircontrols (USA), Inc.
   2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   3. Dampers: Size for larger of manufacturer's listed running torque or 7 inch-lb/sq. ft. of damper.
   4. Coupling: V-bolt and V-shaped, toothed cradle.
   5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   7. Power Requirements (Two-Position Spring Return): 24-V ac.
   8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   10. Temperature Rating: Minus 22 to plus 122 deg F.
   11. Provide position indicators on all actuators.

2.10 CONTROL VALVES

A. Zone Valves:
   1. Zone valves, as specified, shall be by Belimo.Zone Valves.
   2. Zone valves with brass bodies shall be used in terminal unit water applications where sizing or physical limitations prohibit the use of characterized control valves, or in terminal equipment, where water sizing dictates a 2 or 3-way electronic control valve 3/4” or smaller.
   3. The valve manufacturer shall provide the contractor a choice of threaded union male NPT, compression ends or copper sweat ends for each valve.
   4. Zone valve actuators shall have a minimum of 30 psi close-off rating.

B. Controls Valves:
   1. Control valves shall be of the Characterized Control™ Valve type provided by Belimo.
   2. A TEFZEL, flow-characterizing disc shall be installed in the inlet of 2-way characterized control valves and in the control port of 3-way valves. The valve trim shall utilize a stainless steel ball and stem for all water.
   3. Valve bodies shall be forged brass with female NPT threads. Bodies to 1-1/4” shall be rated at 600 psi and sizes 1-1/2” to 2” at 400 psi. The maximum allowable pressure differential shall be 150 psi for on/off and 50 psi for modulating service.
   4. Characterized Control™ Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
   5. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
   6. A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

C. Globe Valves:
   1. Globe valves, as specified, shall be by Belimo.
   2. 2-way and 3-way globe valves may be used only if characterized control valves do not fit the sizing criteria or application.
   3. Globe valves may be used for chilled or hot water. Screwed and flanged water valves shall have equal percentage or linear flow characteristics for 2 or 3-way valves, respectively. All stems shall be stainless steel.
   4. Screwed globe valves 1/2” through 2” shall have bronze bodies rated at ANSI Class 250. Trim shall include SST trim and renewable disc. The maximum differential shall be 35 psi for water and 20 psi for steam.
   5. 2-way and 3-way flanged globe valves 2-1/2” to 6” shall have cast iron bodies rated for ANSI Class 125. The maximum differential shall be 25 psi for water. Trim shall include stainless steel stems, bronze plugs, bronze seats, and a TFE V-ring packing.

D. Direct Coupled Globe Valve Actuator And Adaptor Bracket:
   1. Actuator shall be designed with an integrated adaptor bracket that will direct mount to the valve.
   2. Actuator shall provide a linear force capable of fulfilling the required close-off of the valve.
   3. Actuator shall include an automatic valve coupling device that shall lock securely to the valve stem.
   4. Proportional and spring return actuators shall adapt upon powering the actuator. This adaptation will determine stroke length and enable the actuator to set the minimum and maximum limits of the supplied control signal, thereby utilizing the entire control signal range. Feedback, running time and other parameters are automatically adjusted to the effective stroke.
   5. Actuator shall have a manual override equipped with an inter-locking device to protect the actuator from over-torque of the manual override.

E. Sizing:
   1. Sizing: 5-psig maximum pressure drop at design flow rate.
   2. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

F. Butterfly Valves: 200-psig 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   1. Body Style: Wafer Lug.
   2. Disc Type: Nickel-plated ductile iron or Aluminum bronze.
   3. Sizing: 1-psig maximum pressure drop at design flow rate.

G. Terminal Unit Control Valves: Bronze body, stainless steel trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
   2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
   3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.11 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch minimum thick, galvanized-steel or 0.125-inch minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-hick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
   1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 8 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is tested according to AMCA 500 or 511.

2.12 VARIABLE FREQUENCY CONTROLLERS

A. Provide controller fully compatible with building automation system with all necessary interface hardware cards and software. Drives to be ABB ACH550, Yaskawa Z1000.
   1. All models shall provide a complete, ready-to-install solution.
   2. The latest, most efficient IGBT power technology shall be used. This technology shall be used for all power and voltage ranges offered by the manufacturer.
   3. The VFC shall offer microprocessor based control logic that is isolated from power circuitry.
   4. The VFC shall use the same main control board for all ratings.
   5. Control connections shall remain consistent for all power ratings.
   6. By-pass circuit shall include second disconnect installed in the VFD.

B. The VFC shall employ an active AC to DC rectifier.

C. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating Requirements:
   1. Input ac voltage tolerance of 208 V, plus or minus 5; 380 to 500 V, plus or minus 10 percent.
   2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   4. Minimum Displacement Primary-Side Power Factor: 96 percent.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.

F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

G. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.

4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:
1. Retain one or more of first nine subparagraphs below.
2. Input transient protection by means of surge suppressors.
3. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Adjustable motor overload relays.
5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
6. Instantaneous line-to-line and line-to-ground overcurrent trips.
7. Loss-of-phase protection.
8. Reverse-phase protection.
9. Short-circuit protection.

I. Motor overtemperature fault.

J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Door-mounted LED status lights shall indicate the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

O. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

P. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hertz).

2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. Proportional-integral-derivative (PID) feedback signal (percent).
8. DC-link voltage (volts direct current).
9. Set-point frequency (Hertz).
10. Motor output voltage (volts).

Q. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.
3. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
   a. Output frequency (Hertz).
   b. Output current (load).
   c. DC-link voltage (volts direct current).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set-point frequency (Hertz).

4. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. High- or low-speed limits reached.

R. Communications: Provide interface fully compatible with building automation system to allow VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

S. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

T. Accessories:
1. Devices shall be factory installed in controller enclosure unless otherwise

indicated.

2. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
3. Standard Displays:
   a. Output frequency (Hertz).
   b. Set-point frequency (Hertz).
   c. Motor current (amperes).
   d. DC-link voltage (volts direct current).
   e. Motor torque (percent).
   f. Motor speed (rpm).
   g. Motor output voltage (volts).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify that power supply is available to control units and operator workstation.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install automatic dampers according to Division 23 Section “Air Duct Accessories.”

F. Install damper motors on outside of duct inside buildings, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, cabinets, building wire and cable according to Division 26.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
3. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
4. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
5. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

B. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

C. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing.

B. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. With the Owner’s representative present and at their direction, review and adjust all initial temperature and humidity set points and schedules for occupied, unoccupied and night/weekend setbacks. Review the complete sequence of operations and adjust as requested.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 COMMISSIONING AND TAB VERIFICATION

A. Provide technician with instrumentation for the purpose of commissioning and of verifying the data submitted in the final TAB report. The verification will be conducted by the Commissioning agency.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 09 10 - ADJUSTABLE FREQUENCY VARIABLE TORQUE A/C CONTROLLER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work required under this section of the specification includes all work necessary for the installation of an adjustable frequency controller.

B. A single manufacturer of both motors and controllers shall provide, coordinate, and start-up a drive package to ensure both proper application of the motor to the control and of the drive package to the driven load. The Adjustable Frequency Controller shall be as manufactured by Reliance Electric Company or approved substitute.
   1. The standard Adjustable Frequency Controller (AFC) and all of the optional modifications shall mount within a common NEMA 1 enclosure.
   2. Motor and AFC shall be of the same manufacturer.

C. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. General Provisions, Section 230500.

B. Basic Materials & Methods, Section 230510.

C. HVAC Pumps, Section 232123.

1.3 BASIC DESCRIPTION

A. The adjustable Frequency Controller (AFC) shall be a fully digital PWM using very large scale integration techniques (VSLI) as well as surface-mount technology for increased reliability. The AFC shall use a 16-bit microprocessor with a 12-bit resolution to allow stepless motor control from 0.1% to 110% of motor base speed.

B. All programmable settings shall be held in non-volatile memory and shall not be affected by power outages, brownouts, power dips, etc. The AFC shall have initial programmable settings intact from the factory without the need of battery back-up, etc. The AFC shall not need to be programmed at the job site prior to being able to run a motor, but shall be ready to run a motor as soon as power connections are made.

C. Programming at the job site to accommodate specific local application requirements, such as frequency avoidance and preset speeds shall be available to the user.

D. Complete efficiency versus load and speed for all AFC ratings shall be readily available from the manufacturer. AFC multiple motor operation at the same frequency and speed shall be possible as long as the sum of the connected motor full load sine wave currents are less than or equal to 90% of the AFC maximum continuous current rating.

E. All high voltage components within the enclosure shall be isolated with steel or polycarbonate covers.

1.4 CODE/STANDARDS

A. AFC and options shall be UL listed.

B. The controller and options shall comply with the applicable requirement of the latest standards of ANSI; NEMA ICS 1,2,3 & 6; National Electric Code NEC; NEPU-7; IEEE P598; FCC Part 15 Subpart J; CFR 47.

1.5 EXPERIENCE

A. The manufacturer of the AFC controller described in this specification shall have a minimum of 10 years experience in the design, construction and application of adjustable frequency controls and motors.

1.6 QUALITY ASSURANCE

A. The AFC controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests.

1. The manufacturer shall have been actively and continuously engaged in the production of adjustable frequency controllers for a period of at least 10 years and have experience of at least 8 years in commercial HVAC applications.
2. The Adjustable Frequency Controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

a. Transistors and diodes shall be tested to assure correct function and highest reliability. These tests shall include elevated temperature functional, A-c and D-C parametric tests. Power transistor components shall be lot sample tested functionally and parametrically at 25°C and 125°C when received.
b. Digital integrated circuits shall undergo functional and reliability tests. Tests shall include 168 hour burn-in screening at 145°C according to MIL-STD-83B.
c. Small semi-conductors shall be lot sampled for functional and D-C parameters at room and elevated temperatures when received.
d. Electronic printed circuit board assemblies shall be tested for continuity of field and correct components before they are functionally tested. The major complex circuits shall be temperature cycled for a nominal 24 hour period between 15°C and 55°C. These circuits shall be functionally tested using state-of-the-art computerized test systems.

e. Every Adjustable Frequency Controller shall be functionally tested under motor load and must pass a 20 minute heat run under motor load. In addition, every Adjustable Frequency Controller shall be temperature cycled under constantly varying environmental and line conditions while the unit is cycling a motor under computer control. This test shall be running simultaneously while the temperature is cycled between 7°C and 45°C.
f. These tests will assure that if the Adjustable Frequency Controller is started up according to the manufacturer's instruction manual provided, the unit will run reliably.

1.7 SERVICE

A. The manufacturer shall have the ability to test both the controller and the motor in regional service centers.

1. Start-up shall be included for each Adjustable Frequency Controller provided.
2. The service engineers shall be employed by the manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

B. Training shall be available on site by employees of the manufacturer and shall be in addition to the start-up serviced. Training shall include system concepts and basic troubleshooting.

C. A reasonable supply of spare parts must be kept available for the Adjustable Frequency Controller to meet ordinary repair requirements for the immediate future; and spare parts will be available within 24 hours of notification thru a local service center, by the user.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY CONTROLLER

A. The AFC manufacturer shall provide, at minimum, the electromechanical construction, basic features, adjustments, general options and modifications and special options as outlined in this specification in sections 2.02, 2.03, 2.04 and for the service conditions outlined in section 2.05.

2.2 BASIC FEATURES

The AFC shall have the following basic features:

A. Operators controls shall be mounted on the door of the cabinet and consist of a membrane command center which allows manual stop/start and speed control, local/remote indication and manual or automatic speed control selection. In addition, the command center will serve as a means to configure controller parameters such as minimum speed, maximum speed, acceleration and

deceleration times, volts/Hz ratio, torque boost etc. Potentiometers will not be allowed for these settings.

B. The controller will be able to follow an external speed signal and respond to remote start/stop contacts wired to the terminal strip while in the automatic/remote mode.

C. The optional main input disconnect shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.

D. The controller shall contain an electronic overload circuit designed to protect one A-C motor, operated on the Adjustable Frequency Controller output from extended overload operation on an inverse time basis.

E. Automatic restarts will be attempted three times after a power outage, drive fault or external fault, if the drive is in automatic mode. The circuit shall allow the user to select 0,1,2 or 3 restart attempts as well as select the dwell time between attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.

F. An LED display will be mounted on the door of the cabinet and will digitally indicate:

1. Frequency output.
2. Voltage output.
3. Current output.
4. First fault indication.

G. The Adjustable Frequency Controller shall be capable of starting into a rotating load without the need of a time delay upon a start command.

H. Relay contacts for remote indication of drive fault and motor running shall be provided for interwiring to other devices.

I. User supplied smoke purge N.C. contacts shall force the controller to a preset adjustable speed when opened to allow for a smoke purge function.

J. There shall be three critical frequency avoidance bands which can be programmed in the field via the membrane command center to enable the controller to avoid certain frequencies which the pump or fan system may resonate at due to reduced speed operation. Each critical frequency avoidance band shall have a band width adjustable via keypad entry of up to 10 Hz.

K. There shall be three programmable preset speeds which will force the AFC to a preset speed upon a user contact closure. This feature shall be set digitally by entering via the door mounted membrane command center.

L. The AFC shall have the capability to ride through power dips up to 500 msec without a controller trip depending on load and operating condition.

M. Isolated electrical follower shall enable the Adjustable Frequency Controller to follow a 0-20ma, 4-20ma, or 4-20ma, or 0-4, 0-8, 0-10 volt D-C grounded or ungrounded signal from a process device.

N. Line inductance in the form of line reactors or isolation transformers shall be provided regardless of the KVA connected to the line. This is to minimize line surges, line notching, and voltage distortions from causing nuisance trips with any type Adjustable Frequency Controller.

2.3 PROTECTIVE CIRCUITS AND FEATURES

A. The AFC shall include the following protective circuits and features:

1. DV/DT and DI/DT protection for semiconductors.
2. Instantaneous Electronic Trip for the following faults:

   a. Motor current exceeds 110% for longer than one minute of controller maximum sine wave current rating.
   b. Output phase-to-phase short circuit condition.
   c. Total ground fault under any operating condition.
   d. High input line voltage.
   e. Low input line voltage.
   f. Loss of input phase.
   g. External fault. (This protective circuit shall permit, by means of the terminal strip, wiring of remote N.C. safety contact such as high static, firestat, etc., to shut down the drive.)

3. All live power equipment shall be converted by protective shields to ensure the safety of operating personnel.
4. Metal oxide varistors.

2.4 ADJUSTMENTS

A. The following adjustments shall be provided:

1. Maximum frequency (15 to 400 Hz) with factory setting at 60 Hz.
2. Minimum frequency (5 to 60 Hz) with factory setting at 6 Hz.
3. Acceleration (0.1 to 360 seconds) factory set at 20 seconds.
4. Deceleration (0.1 to 360 seconds) factory set at 20 seconds.
5. Volts/Hertz ratio factory set for 460 volts at 60 Hz.
6. Voltage offset or boost with factory setting at 100% torque.
7. Current limit (50 to 100%) sine wave current rating factory set at 100%.

2.5 SERVICE CONDITIONS

A. The AFC shall be designed and constructed to operate within the following service conditions:

1. Suitable for continuous operation at an ambient temperature of 0°C to 40°C. Elevation up to 3300 ft. altitude with a relative humidity to 95% non-condensing.
2. A-C line variation of -10% to +10% voltage and +/-2% frequency.

2.06 GENERAL OPTIONS AND MODIFICATIONS

A. The following options shall be included as specified in the cover document.

1. Isolation transformer in a NEMA 1 enclosure, for separate mounting, for use on three-phase 60 Hz input power of the voltage specified to provide three-phase, 60 Hz output for the Adjustable Frequency Controller.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 23 09 10

SECTION 23 21 13 - HVAC PIPING

PART 1- GENERAL

1.1 WORK INCLUDED

A. The work required under this section includes all work necessary for the installation of a heating-cooling piping system.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Basic Material and Methods, Section 230510.

B. Insulation, Section 230700.

PART 2 - PRODUCTS

2.1 CIRCULATING WATER PIPING SYSTEM ABOVE GRADE

A. Circulating water piping for heat pump circulating water in sizes up to 2-1/2" shall be ASTM 088-72 Type L copper fittings with solder joints. Piping 3" and larger shall be ASTM A-53 Schedule 40 black steel with steel welding fittings.

2.2 CONDENSATE DRAIN PIPING SYSTEM

A. Condensate drains from room air handling units shall be type 'M' copper with water seal or check valves and shall be extended to storm drain. Drains from roof mounted units to be trapped and spilled on roof with splash blocks.

B. Condensate drains from air handling units shall be type 'M' copper with water seal or check valves and shall be extended to floor drain.

2.3 MISCELLANEOUS PIPING

A. Miscellaneous water supply piping, such as makeup piping to expansion tank, tower tank, full connection to circulating water system, etc., shall be Type "L" copper as specified geotehrmal circulating water piping.

2.4 UNDERGROUND CIRCULATING WATER PIPING SYSTEM (GEOTHERMAL LOOP)

A. Refer to Geothermal Closed-loop Heat Exchangers, Section 232115.

2.5 CIRCULATING WATER SPECIALITIES

A. All circulating water specialties including relief valves, reducing valves, 150 pounds ASME Code compression tank with proper size airtrol fittings and vent tube, rolaritrols, etc., shall be as indicated on the drawings and required. The specialties shall be Armstrong, Bell & Gossett or approved substitute. The specialties shall be installed according to the manufacturer's recommendations so as to eliminate all air in the circulating system.

2.6 STRAINERS, FLEXIBLE COUPLINGS & SAFETY VALVES

A. Strainers shall be iron body with Monel Metal Screen and shall be Crane NO. 998-1/2 or 989-1/2 or approved substitute. Each strainer shall be installed with blow-off valve.

B. Flexible coupling shall be braided stainless steel type good for not less than 125 pounds work pressure and 250°F. operating temperature and be Keflex KSSPC, or approved substitute with control rods.

C. Safety valves for the hot water circulating system shall be Crane 3/4" NO. 2606 or approved substitute, as noted on the drawings.

2.7 VALVES FOR HEAT PUMP LOOP WATER CIRCULATING SYSTEM

A. Valves for cut off in both geothermal loop water circulating systems shall be ball or butterfly type.

B. Ball valves shall be used in sizes up to and including 2" size. Valves shall be 3-piece bronze, full port designed for service without removing from line and have stainless steel stem with PTFE seats. Valves shall be Milwaukee valve 30 BSOF-02 for 200 psi service.

C. Valves 2 ½" to 12" shall be Milwaukee Valve C Series 14" and 24" Milwaukee Valve M Series or approved substitute with 150 psi bubble-tight shutoff. Bronze Disc, EPDM Seat, lug type, multi-position handle and one-piece stainless steel stem. Valves 8" and larger will be weatherproof gear operators suitable for exposed service, with handwheel. 8" and above overhead valves without motor operators shall be chain operated.

D. Check valves in loop water circulating piping shall be a compact silent operating, non-slam type. The valve shall be designed to open and close at approximately 1 foot differential pressure. The valve shall be Armstrong, Bell & Gossett or approved equal.

E. Automatic balancing valves for loop water lines ½" through 4" shall be Hayes, Nexus or Flow Design.

F. Triple duty valves may be substituted for a cutoff valve, check valve, and balancing valve where noted on drawings. Valve shall be capable of all three functions and

be designed for 175 psi working pressure, and be Armstrong or approved substitute.

G. Cut off valves for room units ½" through 1" shall be equal to Milwauke Valve 20BSOR or approved substitute. All bronze construction with BUNA-N seat, stainless steel oval handle, rated for 125 psi working pressure.

PART 3 - EXECUTION

3.1 WELDING PIPING

A. Perform all shop and fields welding work using certified ASME Code Welder. Provide certification of each welder used on this project.

B. All welding shall conform to requirements of the ASME Code, Section B31.9.

C. In welded piping use only flanged joints for valves, and equipment.

3.2 SOLDER PIPING

A. Use 95-5 solder alloys with past flux when joining copper to copper.

B. Use silver solder when joining type "K" copper to copper, when joining refrigerant piping and when making any joint below slab.

C. The use of lead based copper is prohibited.

3.3 Install manual air vents at all high points in piping.

3.4 Connections between copper to ferrous pipe shall be made with dielectric unions. Connections of copper pipe to fittings shall be made with adaptors to provide break between copper and ferrous materials.

3.5 TESTS

A. Test all hydronic piping following installation, but before it is covered or connected to equipment. Furnish necessary labor, materials, and equipment for making test. All leaks disclosed by testing shall be reworked in approved manner and the leaking system shall then be retested until proven tight under pressure. Test all systems for water tightness as required by the authorities having jurisdiction.

B. All hydronic piping shall be tested by applying a hydro-static pressure of not less than 100 pounds per square inch or 1 ½ time the working pressure, whichever is greater.

END OF SECTION 23 21 13

SECTION 23 21 15 - GEOTHERMAL CLOSED-LOOP GROUND HEAT EXCHANGER

PART 1 - GENERAL

1.1 WORK INCLUDED

A The work required under this section includes all work necessary for the installation of a geothermal closed loop ground heat exchanger.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A Basic Materials and Methods, Section 23 05 00.

B. HVAC Piping, Section 232113.

PART 2 - INSTALLATION METHODS AND REQUIREMENTS

2.1 INSTALLATION PERSONNEL AND TRAINING REQUIRED

A. The loop contractor, or contractor designate, must have a current 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 and pipe fusion tests.

B. Ground heat exchanger fabricators must have completed a heat fusion school in which each participant has performed heat fusion procedures under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician must be throughly familiar with heat fusion procedures and have had formal training and testing at a heat fusion school under direct supervision of an IGSHPA certified instructor.

1. Certified pipe fusion technicians must attend a retaining school every three years. A single failure of a fusion joint will void the certification, and the technician must be retested to demonstrate satisfactory performance.

C. Local and State laws and ordinances as they pertain to buried pipe systems shall be strictly followed or a variance obtained.

2.2 INSTALLATION METHODS AND COMPLIANCE

A. The manufacturers installation procedure must follow a recognized methodology such as presented in the most recent editions of:

1. Closed-Loop / Ground-Source Heat Pump Systems: Installation Guide,

IGSHPA Publications, Oklahoma State University.

2. Data Design Manual for Closed-Loop / Ground-Source Heat Pump Systems, ASHRAE.

B. The ground heat exchanger installation must be clearly documented in order to determine compliance with the heat pump manufacturers and/or utilities specification. This includes maintaining a drill log indicating at a minimum: bore location and depth, casing length and location (if require) water encountered (depth, estimated flow rate and water column height prior to backfill.)

C. Soil thermal values shall be used in calculating loop length, if different from design, using soil tests as needed. See IGSHPA Soil Rock Classification Manual and Soil Conservation Service Survey for county/parish data which can be obtained from the local SCS office.

2.3 GROUND HEAT EXCHANGER MATERIALS

A. Acceptable pipe material for the underground buried portion of the ground exchanger is polyethylene as specified below. Pipe shall be CPChem Driscoplex 5300 Series Climate Guard or approved equal.

B. Specifications for the polyethylene heat exchanger are as follows:

1. GENERAL. All pipe and heat fused materials shall be material in accordance with ASTM D-2513, Section 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness and respective tolerances as specified in ASTM D-3035.
2. MATERIAL. The material shall maintain a 1600 psi Hydrostatic Design Basis at 73.4 degrees F per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. The material shall be high density, polyethylene extrusion compound having a cell classification of 345444C as specified in ASTM D-3350. Pipe and fittings shall be constructed from same material.
3. DIMENSIONS

   a. Pipe with a diameter less than 3" (nominal) shall be manufactured in accordance with ASTM D-3035 with a maximum dimension ratio of SDR-11. Vertical U-tubes in bores exceeding 400 feet in depth shall be SDR-9.
   b. Pipe 3" (nominal) and larger diameter shall be manufactured in accordance with ASTM D-3035 with a maximum dimension ratio of SDR15.5.

4. MARKINGS. Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard. Coils shall be marked with footage marks at intervals no greater than two feet.
5. CERTIFICATION MATERIALS. Manufacturer shall supply a notarized document confirming compliance with the above standards (I.C.2.1. through I.C.2.4.).
6. WARRANTY MATERIALS. Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance.

2.4 PIPE JOINING MATERIALS

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 manufacturers procedures. Pipe sizes 2" shall be joined by socket fusion. Pipe sizes 3" and greater may be joined by butt fusion.

C. Fused transition fittings with re-enforced threads must be used to adapt to copper or high strength hose connections to the circulating pump and heat pump. Barbed fittings are not permitted in polyethylene pipe.

2.5 CASING

A. The GSC shall provide a minimum of 80 feet of steel casing at each well bore hole. Provide a unit cost per foot for extra casing in bid.

B. The GSC may use removable smooth bore pipe, threaded internally so that casing can be removed after insertion of heat exchanger piping.

2.6 FLUSHING, PURGING, PRESSURE AND FLOW TESTING

A. All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage.

B. All vertical loops will be pressure tested before installation and all horizontal components of the ground heat exchanger will be pressure tested prior to backfilling.

C. Heat exchangers will be tested hydrostatically at the smaller of 150% of the pipe design rating or 300% of the system operating pressure. Test shall be limited to a maximum of 8 hours at 150% of the design rating.

D. No leaks shall occur within an 8 hour time period. A maximum of 10% pressure drop due to exchanger expansion is acceptable.

E. Flow rates and pressure drops will be compared to calculated values to assure that there is no blockage or kinking of any pipe.

F. A minimum velocity of 2ft/sec in each piping section must be maintained for a minimum of 15 minutes to remove <u>all air</u>. A change of more than one inch in the level of fluid in the purge pump tank during pressurization indicates air still trapped in the system.

PART 3 - EXECUTION

3.1 HORIZONTAL PIPING SYSTEMS

A. Sharp bending of pipe around trench corners must be prevented by using a shovel to round corners. Manufacturers procedures must be followed.

B. Backfilling procedure shall include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling.

C. All buried GSHP pipes in systems containing antifreeze passing parallel within 5 feet of any wall, structure, or water pipe shall be insulated with R2 minimum closed cell insulation.

3.2 EXCAVATING FOR MECHANICAL WORK

A. General: Do not excavate for mechanical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimized.

B. Excavate with vertical-sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Remove sheeting and cross-bracing during backfilling wherever such removal would not endanger the work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.

C. Depth for Direct Support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand-excavate bottom cut to accurate elevations.

D. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

E. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

F. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

G. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe.

H. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.

I. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone of gravel prior to installation of pipe. Grade bottoms of trenches as indicated, notching under couplings to provide solid bearing for entire body of pipe.

J. Excavate near large trees (with drop-line) by hand, and protect the root system from damage or dryout to greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with asphaltic tree paint.

3.3 BACKFILLING

A. General: Except as otherwise indicated, backfill with properly qualified backfill material.

B. Backfill with finely-graded subbase material to 6" above wrapped, coated and plastic materials.

C. Condition backfill material by either drying or adding water uniformly, to whatever may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.

D. Backfill simultaneously on opposite sides of mechanical work, compact simultaneously; do not dislocate the work from installed positions.

E. Backfill excavations in 8" high courses of backfilling material, uniformly compacted to the following densities (5 of maximum density, ASTM D-1557), using power-driven hand-operated compaction equipment. All compaction shall be in accordance with civil engineering requirements. See civil drawings and specifications.

F. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work.

G. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.

H. Do not backfill trenches until tests and inspections have been made and avoid damage or displacement of pipe system.

I. Compaction Tests: Where compaction tests indicated lower densities of backfill than specified, continue compaction (and re-excavation and backfilling where necessary) and provide additional testing as directed by Architect/Engineer. The allowable density tolerance is not more than one-test-out-of-5 falling more than two (2) percent points below specified density.

END OF SECTION 23 21 15

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in dry location.

B. Retain protective covers for flanges and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Bell & Gossett Series 1510
   2. Taco, Inc. Series FI

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, top center-line discharge, self-venting casing, end-suction pump as; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 200 deg F.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
   5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed premium efficiency, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment.

H. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

3.2 CONCRETE BASES

A. Install pumps on concrete bases. Refer to Division 23 Section "Common Work Results for HVAC."

3.3 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

3.4 ALIGNMENT

A. Comply with pump and coupling manufacturers' written instructions for alignment of pump and motor shafts.

B. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install triple-duty valve on discharge side of pumps.

C. Install suction diffuser and shutoff valve on suction side of pumps.

D. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

E. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work required under this section of the specification include all work necessary for the complete installation of a refrigerant piping system.

B. The work of this section is subject to the requirements of the Mechanical General Provisions and Basic Materials Specifications.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING SYSTEM

A. The refrigerant piping shall be Type L copper with wrought copper fittings and high temperature solder joints, silfos, or approved substitute. The piping system shall include but not be limited to the following: liquid line solenoid valves, hot gas bypass and control where noted, charging valves sight glass with moisture indicator, liquid line strainer drier, flexible connectors where required. The piping shall be installed according to the diagrams furnished by the manufacturer's Engineer for approval prior to installation. The piping system shall be tested at 200 pounds with dry nitrogen until all leaks have been made tight. After the pressure test use suitable vacuum pump to evacuate the system to a least 1000 microns, then charge the system with refrigerant, all safety and operating devices and controls shall be properly adjusted and tested for proper operation and protection of the equipment.

PART 3 - EXECUTION

3.1 Route all refrigerant piping between condensing units and evaporator coils by the most direct route possible in order to minimize refrigerant line length.

3.2 All refrigerant piping must be supported from the building structure and affixed to the structures.

3.3 Reasonable measures should be taken to insure that the installed refrigerant piping forms no traps for the system lubricating oil.

3.4 Refrigerant piping extending through the roof shall be sleeved, water proofed and flashed watertight.

3.5 Refrigerant piping underground shall be run in PVC piping sleeve. Seal openings between PVC sleeve. Seal openings between PVC sleeve and refrigerant piping with foam to form a weatherproof seal.

3.6 All refrigerant suction and hot gas lines shall be insulated with flexible tubular elastomeric insulation as required in section 23.07.00 hereinbefore.

END OF SECTION 23 23 00

SECTION 23 30 00 - AIR DISTRIBUTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work required under this section includes all work necessary for the complete installation of an air distribution system.

B. The work of this section is subject to the requirements of the Mechanical General Provisions and Basic Materials specifications.

1.2 CERTIFIED RATINGS

A. All fans shall have AMCA certified ratings and be UL listed.

PART 2 - PRODUCTS

2.1 FANS

A. Roof Exhaust Fans shall be Cook, Penn, Greenheck, or as approved low contour power roof type, each complete with: aluminum weatherproof housing with square turned down flanged base for curb mounting, centrifugal wheel; vertical grease lubricated ball bearing motor; vibration absorbing mountings for all rotating parts; bird screen; gravity back draft shutters; and direct or belt drive, as required for the fan involved. Belt drive fans shall have sealed permanently lubricated ball bearings, Vee belt drives, adjustable pitch motor sheaves, and belt adjusting means. Each 1/2 hp and smaller single phase roof fan shall have suitable toggle type disconnect switch furnished and mounted in the fan enclosure by the fan manufacturer.

1. Roof curbs: All roof curbs shall be of galvanized steel construction with flashings, roof fastenings, and 1" thick fiberglass anti-sweat thermal insulation. Provide sloped curb if required by roof pitch. Roof curbs shall be selected to match the roof conditions. As a minimum, the exhaust fan base must be 12" above the roof, with height of the curb to compensate for roof insulation thickness. Contractor should determine exact height of curb required at each unit location and shall verify roof construction with the architectural drawings and specifications and existing conditions if warranted.
2. Excessive noise: at Contractor's expense, each roof exhaust fan which has a sound level higher than that scheduled for the fan involved or is otherwise excessively noisy shall be removed and replaced with an acceptable roof exhaust fan.

B. Ceiling fans shall be direct drive centrifugal type with grille, insulated housing, wall switch, backdraft damper, and discharge duct to roof with roof jack.

C. In-Line Fans shall be duct mounted type, direct connected or belt drive as scheduled, each complete with: square or tubular metal housing, with duct connection flanges: NEMA standard 1,800 maximum rpm sealed grease lubricated ball bearing motor; centrifugal wheel; and vibration absorbing mountings for rotating parts or entire fan assembly. Each belt drive fan shall have: fan shaft mounted on grease lubricated ball bearings, either sealed type or with accessible lubricating fittings on housing exterior; Vee belt drive; adjustable pitch motor sheave ONLY for fan with single belts; belt adjusting means; and belt guard.

D. Kitchen Hood Supply Air Fans shall be side intake, roof mounted, belt driven, centrifugal filtered supply air fans. Fan housing shall be fabricated of painted galvanized steel and square turned down flanged base for curb mounting. Unit shall have insulated top cover and 1" washable aluminum mesh filter.

1. Each fan shall a heavy duty, permanently lubricated sealed ball bearing motor, which shall operate at the voltage and phase as specified on the drawings. Units shall also have DWDI centrifugal forward curved fan wheels, balanced in accordance with AMCA Standards, and mounted on fan wheel shaft with permanently lubricated sealed ball bearings. The fan shall have: Vee belt drive, adjustable pitch motor sheave only for fans with single belts and belt adjusting means.
2. Roof curbs: All roof curbs shall be of galvanized steel construction with flashings, roof fastenings, and 1" thick fiberglass anti-sweat thermal insulation. Provide sloped curb if required by roof pitch. Roof curbs shall be selected to match the roof conditions. As a minimum, the exhaust fan base must be 12" above the roof, with height of the curb to compensate for roof insulation thickness. Contractor should determine exact height of curb required at each unit location and shall verify roof construction with the architectural drawings and specifications and existing conditions if warranted.

2.2 DUCTWORK

A. Type:

1. All ductwork shall be sheet metal unless noted otherwise (26 ga. minimum.)
2. Ductwork type as follows:

   a. Supply return and outside air duct on constant volume system to be low pressure.
   b. Exhaust duct to be low pressure.

B. Low Pressure Sheet Metal Ductwork:

1. Sheet metal work, unless noted otherwise, shall be fabricated of Armco Zincgrip-Paintgrip galvanized steel where exposed to weather or to be painted. Sheet metal for concealed ductwork shall be fabricated of

galvanized steel, and be "Bethcon", as manufactured by Bethlehem Steel Company, or "Softite", as manufactured by Wheeling or approved substitute.

2. Ducts shall be sizes shown on the drawings, crossbroken, rigidly braced, adequately supported and securely fastened in place. Fabricate and install ducts in accordance with latest SMACNA Duct manual details.
3. Duct connections 24" wide and larger to be made using the "Ductmate System" or approved substitute. The installation to be complete using angles, corners, cleats, gaskets, sealer, and bolts. Install according to Manufacturers instructions.

C. Leakage Testing of Installed System Acceptance Criteria:

1. The installed duct system shall be tested to the designed operating pressure. This includes supply, return, and exhaust duct.
2. The air leakage at the test pressure shall be measured by a calibrated orifice type of flow meter. Total allowable leakage of the system shall not exceed ½ % of the air handling design capacity of the system.
3. Leakage concentrated at one point may result in objectionable noise even if the system passes the leakage rate criteria. This noise source must be corrected to the satisfaction of the engineer.
4. The orifice flow measurement device must have been individually calibrated against a primary standard, and this calibrated curve permanently attached to the orifice tube assembly.

D. Joint Sealing:

1. All joints shall be sealed with an approved duct sealer specifically formulated for sealing the field joints in duct systems. Sealer for low pressure duct systems (<2"w.g.) Shall be Ductmate Proseal or Foster 32-17 water based sealants.
2. Flanged joints shall be sealed by neoprene rubber gaskets.

2.3 DUCT ACCESSORIES

A. Fire Dampers - All fire dampers shall be Type B, constructed and tested for compliance with the latest edition of UL Standard 555. All dampers shall bear the UL label. Each damper shall be suitable for use in either the horizontal or vertical position and must include an integral drive spring. Sleeves and collars shall be furnished with fire dampers. Dampers shall be designed so as not to restrict air flow. A suitable access door in duct shall be provided for resetting all fire dampers. Install all dampers in accordance with all manufacturer installation instructions.

B. Louvers - Louvers in outside walls shall be high performance, drainable blade weather louvers. Louver to have extruded aluminum construction with anodized finish, color by Architect and 4" frame thickness. Adjustable louvers to have vinyl blade gasket. Louvers to have 0.15" wg., pressure drop maximum at 900 fpm velocity through free area and no water carryover at designed air flow. All louvers to have aluminum bird screen and exterior frame. All louvers are stationary type unless noted on drawings, and shall have AMCA seal.

C. Combination Fire/Smoke Dampers - All combination fire/smoke dampers shall be constructed and tested for compliance with the latest editions of UL Standard 555 and 555S. All dampers shall bear the UL label. The 120 volt (or 24 volt - designer specify) electric (or pneumatic - designer specify) damper shall be rated to 350° Fahrenheit, with blade seals of silicone rubber capable of withstanding 450° Fahrenheit. Additionally, the damper must be factory supplied with an actuator and sleeve to comply with the requirements of UL 555 and UL 555S. Install all dampers in accordance with all manufacturer installation instructions. Provide a suitable access door in duct for resetting of damper.

D. Brick Vents:

1. Brick vents in exterior walls shall be fabricated of extruded aluminum, 4" deep, with 45°blades. Frame and blades shall be 0.125" thick. Brick vent color shall be as selected by the architect.

E. Manual Balancing Dampers:

1. Manual balancing dampers in rectangular ducts shall be American Warming. Dampers in duct runs and branches shall be Model VC-21. Dampers to be constructed of 16 ga galvanized steel, with vinyl seals for low leakage at shutoff. All dampers to be caulked with silicone between damper and duct, and have external adjustment marked Open-Closed. Dampers shall be furnished with controls when motor operated. Dampers to be opposed blade type if either side is 12" or larger. Dampers under 12" may be single blade type.
2. Manual Balancing Dampers in round ducts shall be American Warming Model VC-22 in sizes up to and including 10" and Model VC-23 in sizes 12" and larger. Dampers to be 16 ga galvanized steel. Provide EPT sponge seals for low leakage.
3. Dampers to have 1% leakage rate at 1" wg duct pressure in accordance with AMCA 500.
4. All dampers to be installed with 2" standoff bracket.
5. Dampers with motor operated control to be furnished under Section 15900 by control contractor.

F. Flexible Duct:

1. Flexible connections from main to terminal supply diffusers may be used above accessible ceiling areas.
2. Flexible duct shall be UL listed Class 1 air duct connector and be Flexmaster type 4M or approved substitute, with 1-1/2", 3/4 pound density

glass fiber with flame resistant vapor barrier, R=6.0. Maximum lengths not to exceed 5 feet. Provide air tight inner liner, wire helix, and reinforced metalized outer jacket.

3. Use adjustable steel strap clamps or flexible nylon wire ties when attaching flexible duct to sheet metal collars. Wrap duct and collar with 2" wide duct tape before attaching clamp.
4. System to be UL 181, SBCC, BOCA, NFPA 90A & 90E, and HUD approved.
5. Do not use flexible duct in return or exhaust systems.

G. Grilles, Registers, and Ceiling Outlets:

1. All flat grilles and registers shall be as scheduled on drawings, or approved substitute, as scheduled on the drawings, with baked enamel finish; color as selected by Architect.
2. Coordinate location with reflected ceiling plans.
3. Provide square to round adaptors if required.
4. All outlets and inlets to have sealing gaskets and volume control dampers. Provide frame suitable for wall or ceiling installation used. Verify with Architectural drawings.
5. Diffusers in UL ceilings to be steel with radiation damper and insulation blanket.

H. Roof Air Intakes and Reliefs - Roof air intake and outlet assemblies shall be Jenn Air, Penn, or as approved factory fabricated air hood, complete with: all aluminum weatherproof construction; lock formed or welded seams; turned down flanged base for curb mounting; removable hood; angle framing and reinforcement; bird screens; and damper with gasketed blade edges. Dampers shall be motor operated where indicated otherwise, dampers shall be gravity operated (See Control System, hereinafter). Dampers for reliefs to have counterbalance weights and anti-sweat covering. Provide factory fabricated aluminum or galvanized steel roof curb assembly with flashings for each roof air intake. Roof curbs shall be selected to match the roof conditions. As a minimum, the base of the intake or relief must be 12" above the finished roof. Contractor should determine exact height of curb required at each unit location and shall verify roof construction with the architectural drawings and specifications and existing conditions if warranted.

I. Flexible Connectors:

1. Provide flexible connectors between each air unit or fan and the duct distribution, on both the supply side and the return side.
2. Connectors shall not exceed 10 inches in lengths.
3. Connectors to be of an approved flame retardant fabric with a maximum flame spread of (25) and a maximum smoke development rating of (50).
4. All connectors on supply duct to be insulated.

J. Branch Connections:

1. Main Supply Branch: (See SMACNA Manual Figure 2-7, 2-8) use unvaned radius transition elbow with splitter damper when branch width is 36" or smaller, and vaned square throat transition elbow when branch width is larger than 36".
2. Sub-Branch Supply: (See SMACNA Manual Figure 2-16) use straight tap with extractor, having manual control rod extended thru main branch side, when extractor weight is 50 lbs or less. For sub-branch sizes where extractor would be heavier than 50 lbs, use 45° or radius entry clinch lock collar. (See SMACNA Figure 2-8, and manual balancing dampers.)
3. Sub-Branch Return: (See SMACNA Manual Figure 2-8) use 45° or radius entry clinch lock collar. (Provide each with manual balancing damper.)
4. Round Supply Take-Offs: Use factory fabricated rectangular to round type galvanized steel fittings and 26 ga manual balancing damper with 2 wing nuts and handle. System to be Crown Model 3300-DS or approved substitute. Provide 2" stand off bracket.
5. Round Return/Exhaust Tap-ins: Use factory fabricated beaded straight spin-in type galvanized steel tap fittings.
6. For low pressure return and/or exhaust application of duct connectors to square ceiling mounted grilles or registers, use factory fabricated square-to-round galvanized steel minimum 3" deep adapter boxes having 2" long beaded round collar.

K. Vanes and Deflectors:

1. Vanes and deflectors to be galvanized steel sheet same thickness as used in ductwork of corresponding size. Vanes to be securely anchored to duct or casing and have freestanding edges braced as necessary for making rigid.

L. Transitions:

1. Increase-in-area transition: Transformation slope not to exceed 20°.
2. Decrease-in-area transition: Transition slope to be maximum 30°, but 20° is preferable.
3. Angle of transformation at connections to heaters or other equipment not to exceed 30° on approaching side of equipment and 45° on leaving side. Angle of approach may be increased to meet space conditions when transformation section is provided with vanes.

M. Elbows:

1. Elbows shall be either full radius type or square throat with turning vanes. No mitred elbows allowed. Short radius elbows with vanes also allowed.
2. Unvaned full radius elbow, shall have throat radius equal to width of duct and full heel radius over than 36" in width.

3. All square heel elbows shall have 3" square throat elbow with large class single thickness vanes thru 36" unsupported vane length and large double thickness vanes for unsupported vane length of 37" thru 72" as per SMACNA Manual Figures 2-3 and 2-4.

2.4 ELECTRIC COILS

A. The electric heating coils shall conform to the applicable portions of Paragraph 422-27 of the National Electric Code, shall be Underwriters' listed, and suitable for the use intended. The heaters shall be for the voltage and phase called for on the drawings or equipment descriptions. Multiple step heaters shall be so arranged that stratification of the heat through the heater will be at a minimum when operating at light loading. Each heater shall be complete with enclosed contactors, air flow switch, control voltage transformers, 200°F high limit thermostat, internal wiring to enclosed terminal, internal fusing, and be ready for connection by the electrician. The number and capacity of the heaters and circuits shall be as called for on the drawings.

B. Where required, fused disconnect switches shall be furnished for the heaters. The Contractor shall make an allowance in his price for all field wiring and materials not shown or included on the electrical drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Air Distribution Equipment as specified above and as recommended by manufacturer.

B. Sheet metal ducts shall be securely supported, hung or suspended by metal trapeze hangers or straps having a minimum width of one inch. Nails or screws shall not be driven through the duct walls.

C. All duct joints and seams shall be securely fastened and sealed to make air tight. All leaks shall be sealed with Hardcast.

D. All exposed openings in fan housing shall be protected with screens or gratings. All fans shall have belt guards on exposed drives.

E. Flexible duct connectors shall not pass through a fire wall or a partition having a fire resistance rating of (1) hour or more.

F. Do not install flexible ducts that have more than a 90° turn.

G. Contractor to verify duct sizes and fittings required with actual field measurements before fabrication of ductwork. The contractor shall not receive compensation for ductwork fabricated that cannot be used. See section 3.02.

3.2 EXCESSIVE NOISE AND VIBRATION

A. All air distribution equipment was selected for a noise level recommended for the space it serves. Any equipment causing excess noise or vibration will be replaced at the Contractor's expense.

END OF SECTION 23 30 00

SECTION 23 34 00 – HVAC FANS

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.

B. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed control to provide cooling and destratification.

1.2 SUMMARY

A. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

B. Related Sections include the following:
   1. Division 00 General Requirements
   2. Division 21 Fire Suppression
   3. Division 23 Heating Ventilation and Air Conditioning

1.3 REFERENCES

A. National Fire Protection Agency (NFPA)

B. Underwriters Laboratory (UL)

C. National Electric Code (NEC)

D. International Organization for Standardization (ISO

1.4 SUBMITTALS

A. Product Datacenter
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the large format fans.

B. Shop Drawings
   1. Include typical dimensioned plans, elevations and cross-section(s) of the fan units and attachment to the structure.at the location of the unit, indicating
      a. Dimensions as shown on the drawings.

b. Finish as shown on the drawings.
c. Samples: For each exposed product and for each color and texture specified.
1) Size: 12 inches

2. Provide Qualification of Installers

C. Shop drawings shall include the following note completed and signed by the Contractor:
1. THE DATA SUBMITTED DOES NOT CONTAIN MATERIAL DEVIATION FROM REQUIREMENTS OF CONTRACT DOCUMENTS EXCEPT AS FOLLOWS

1.5 QUALITY ASSURANCE

A. Certifications
1. The fan assembly, as a system, shall be TUV-certified and built pursuant to the guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.
2. The fan shall be compliant with NFPA 13—Standard for the Installation of Sprinkler Systems, NFPA 72— National Fire Alarm and Signaling Code, and NFPA 70-2011—NEC.
3. Controllers shall comply with NEC and UL standards and shall be labeled where required by code.

B. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by manufacturer with a minimum of 10 years experience and with sufficient trained staff to install manufacturer's products according to specified requirements.

C. ISO 9001-certified

1.6 PRE-INSTALLATION MEETINGS

A. Conduct the conference at the job site on a date and time set a minimum of 2 weeks in advance of beginning work.
1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, Installer, system manufacturer's representative, adjacent materials Installer, and installers whose work interfaces with or affects the wall transition to the windows.
2. Review methods and procedures related to installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine substrate and surrounding conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of walls and windows during and after installation.

B. Review governing regulations and requirements for insurance and certificates if applicable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.

B. The fan and its components must be stored in a safe, dry location until installation.

1.8 WARRANTY

A. The Warranty Period for surfaces with enhanced finishes (painted, anodized, etc.) on Essence shall be limited to one year. The manufacturer shall replace any products or components defective in material or workmanship for the customer free of charge (including transportation charges within the USA, FOB Lexington, KY), pursuant to the complete terms and conditions of the Big Ass Fans Non-Prorated Warranty in accordance to the following schedule:

Item	Period of Coverage
Hub and airfoils	Lifetime (Parts)†
Motor, drive, and controller	10 years††
Labor	1 year††
Enhanced finishes†††	1 year†††

† "Lifetime" means a period ending seven (7) years after Big Ass Fans discontinues manufacturing the product, as such period is defined by Big Ass Fans, but in no event shall this period be less than 10 years from the date that the Warranty Period commences, as defined above.

†† The 10-Year Warranty Period and 1-Year Labor apply to non-residential installations only, and requires purchased installation by a factory-approved, Big Ass Fans certified installer and the submission of installation documentation by such installer. A 5-Year Warranty Period will apply for proper installations by any other state qualified or licensed electrical contractor. The Warranty is void in its entirety if the product is installed by personnel other than a state qualified or licensed contractor.

††† The 1-year enhanced finishes warranty applies to outdoor installations only.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, basis of design: Product specifications are based upon the first named manufacturer. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Delta T Corporation. Big Ass Fans
   2. Glocon, Inc., Swifter
   3. MacroAir, AirSpan

B. Substitutions will only be permitted if the procedures are followed in Division 01.

2.2 MATERIALS

A. Complete Unit
   1. Regulatory Requirements: The entire fan assembly shall be TUV-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2. No. 113.
   2. Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification of conditioned commercial applications over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not exceed 40 dBA. Actual results of sound measurements in the field may vary due to sound reflective surfaces and environmental conditions.
   3. Good workmanship shall be evident in all aspects of construction. Field balancing of the airfoils shall not be necessary.

B. Controls
   1. The fan controller shall be incorporated into the fan assembly and housed in an enclosure independent of the motor to prevent overheating or electrical interference. The fan controller shall be factory programmed to minimize starting and braking torques and shall be equipped with a simple diagnostic program and an LED light to identify and relay faults in the system.

C. Airfoil System
   1. The fan shall be equipped with eight (8) high volume, low speed airfoils of precision extruded, anodized aluminum alloy. Each airfoil shall be of the high-performance Mini-Elipto design. The airfoils shall be connected to the hub and interlocked with eight (8) stainless steel retainers and two (2) sets of stainless steel bolts and lock washers per airfoil.

   1. The fan shall be equipped with eight (8) upswept winglets designed to redirect outward airflow downward, thereby enhancing efficiency. The winglets shall be molded of high strength polymer and shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the winglets shall be silver or black.
   2. As an option, the fan shall be equipped with eight (8) plug-style airfoil tips, molded of high strength polymer, in place of the eight (8) upswept winglets. The airfoil tips shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the airfoil tips shall be black.

D. Motor
   1. The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0–100% without the use of a gearbox or other mechanical means of control. The motor shall operate from any voltage ranging from 100–120 VAC or 200–240 VAC, single phase, and 50/60Hz, without requiring adapters or customer selection. The motor shall be a non-ventilated, heat sink design with the capability of continuous operation in -13°F to 131°F (-25°C to 55°C) ambient condition. The standard color of the motor unit shall be white with silver trim or silver with black trim.
   2. The motor shall be rated at one of the following:
      a. 8-ft fan average power @ max speed = 475 Watts

b. 10-ft fan average power @ max speed = 425 Watts
c. 12-ft fan average power @ max speed = 350 Watts
d. 14-ft fan average power @ max speed = 300 Watts

E. Mounting System
1. The fan mounting system shall be designed for quick and secure installation from a variety of structural supports. All components in the mounting system shall be of formed metal design using low-carbon steel no less than 3/16" (0.5 cm) thick and containing no critical welds. The mounting system shall be powder coated for appearance and resistance to corrosion. All mounting bolts shall be metric stainless steel or equivalent. No mounting hardware substitutions, including cast aluminum, are acceptable.
2. The fan extension tube shall be a round, extruded aluminum tube. The extension tube shall include a chrome plate with forward and reverse controls and a fan status indicator light that is visible from the floor.

F. Hub
1. The fan hub shall be constructed of zinc plated steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly.

G. Safety Cable
1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/16" (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel, pre-loaded and tested to 3,200 lbf (13,345 N).
2. Field construction of safety cables is not permitted.

H. Wall Control
1. Wired (standard). The fan shall be equipped with a low-voltage wired remote wall control providing control of all fan functions. The wall control shall be capable of mounting to a standard electrical box or directly to a wall surface. The wall control shall include a rotary-style dial for controlling the fan's power and speed and an LED light to identify and relay faults in the system. Communication with the fan drive and controller shall be by a standard, commercially available CAT5 (or higher) Ethernet cable that is field installed and provided by the installer.
2. Wireless (optional). As an option, the fan shall be equipped with an optional radio frequency (RF) remote wall control in place of the wired wall control. The wall control shall provide control of all fan functions. The wall control shall be capable of mounting to a standard electrical box with an owner-supplied wall plate and shall include a capacitive touch display for controlling the fan's power and speed. Communication with the fan drive and controller shall be wireless.

I. Fire Control Panel Integration
1. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

J. Guy Wires
2. Guy wires shall be included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect surrounding and adjacent work as required preventing damage to preceding work during execution of this work.

B. Perform all preparation necessary for a successful installation of products as specified in manufacturer's installation instructions.

C. Fan location must have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

D. Mounting structure must be able to support weight and operational torque of fan. Consult structural engineer if necessary.

E. Fan location must be free from obstacles such as lights, cables, or other building components.

F. Check fan location for proper electrical requirements. Consult Installation Guide for appropriate circuit requirements.

G. Each fan requires dedicated branch circuit protection

3.2 INSTALLATION

A. The fan shall be installed by a factory-certified installer according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle irons for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.

B. Minimum Distances
   1. Airfoils must be at least 10 ft (3 m) above the floor.
   2. Installation area must be free of obstructions such as lights, cables, sprinklers, or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.
   3. The structure the fan is attached to shall be capable of supporting a torque load of up to 40 ft·lb (54 N·m) of torque.

C. The fan shall not be located where it shall be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.

D. The fan is suitable for use in wet locations when installed on a GFCI protected branch circuit.

E. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
   1. The maximum fan diameter shall be 24 ft (7.3 m).
   2. The HVLS fan shall be centered approximately between four adjacent sprinklers.

3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).
4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72—National Fire Alarm and Signaling Code.

3.3 FIELD QUALITY CONTROL

A. After installation, check all work for flaws and defects.

B. Repair all defective work.

C. Remove and replace all damaged components that cannot be successfully repaired as determined by Project Architect

3.4 PROTECTION

A. Protect surfaces from damage until Date of Substantial Completion. Repair or replace damaged components that cannot be repaired to architect's satisfaction.

B. Fabricator/Installer to provide a Maintenance kit and shall review maintenance procedures and the product warranty with the Owner's maintenance personnel upon completion of project.

3.5 CLEANING

A. Remove all protection materials.

B. Clean all surfaces following manufacturer's recommendations prior to final project completion. Do not use harsh cleaning materials or methods that would damage finish.

C. Dispose properly of all debris generated by this work, protection materials and cleaning materials.

END OF SECTION 23 34 00

SECTION 23 38 13 - KITCHEN HOOD

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work under this section includes all work necessary for the complete installation of a kitchen range hood.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

PART 2 - PRODUCTS

2.1 KITCHEN HOOD

A. Furnish and install where shown on plans a complete UL classified, State of Tennessee approved, range hood and ventilator system. The complete system shall comply with NFPA-96 Edition and shall bear the UL label as well as the NSF seal. The hood shall be equipped with UL high velocity centrifugal stainless steel grease extractor type filters. Prior approval shall be obtained on any proposed substitution no later than 10 days before bid date. Hood submittals shall include cooking equipment layout under hood, lighting fixtures, wiring diagrams, filters and ansul fire suppression system information and ansul pull station submittal.

B. The hood supply and exhaust fans shall be complete with disconnects, starters, and contactors. Standard control panel shall be complete with "ON/OFF" switch and fan "ON" light. Wiring shall meet local and national codes. Incandescent lights shall be furnished. Automatic energy shut-off shall be provided for cooking equipment located under hoods.

C. The hood and exposed duct shall be constructed of 18 gauge 304 stainless steel. Exhaust ductwork from hood collar(s) to exhaust fan shall be 16 gauge liquid tight welded steel. Exhaust duct must extend a minimum of 18" above roof line. Provide a canopy extension (closure panel) between top of hood and ceiling if required. This extension to be 20 gauge stainless steel.

D. The hood shall be supplied with a UL listed wet chemical fire protection system. The pressure container for this system and the remote emergency fire station shall be installed in the field by qualified personnel. The operation of the system shall automatically shut off fuel to all equipment under the hood protected by the extinguishing system.

E. The hood supply duct shall be insulated below the roof level.

F. Provide supply and exhaust hoods as shown on plans. Mount hood 6'6" from finished floor to the lowest point of canopy.

G. The inner canopy, filter racks, grease trough, etc., shall be constructed of 18 gauge stainless steel. Top of canopy shall be framed suitable for attaching using threaded rods with turn buckles. Canopy shall be furnished in two sections for bolting together on the job.

H. System shall be furnished with vapor-proof incandescent lights, one every 3' of canopy perimeter, pre-wired to junction boxes mounted on top of canopy.

I. Provide 1-1/4" wide by 1/4" deep grease troughs beneath filters.

J. A fire damper actuated at a maximum of 286°F must be installed in the hood supply collar.

K. All joints including hood and exhaust duct shall be made liquid-tight with a continuous external weld. Provide suitable number and size of access doors in ductwork to permit a thorough cleaning of the entire system. A sign must be placed on all access doors stating the following: “ACCESS PANEL - DO NOT OBSTRUCT”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Approval:

1. Inspections and approval by State Fire Marshal and/or insurance inspectors shall be obtained by Contractor as part of this work.
2. Equipment shall be UL listed and FM approved.

B. Verify hood size and required capture area and location with kitchen equipment drawings prior to ordering.

3.2 All exhaust duct from hood exhaust duct collar(s) to roof deck shall be wrapped with a fire rated insulation system. Refer to Insulation Specification Section 15180, Part 2, 2.06 Fire-Rated Insulation Systems.

END OF SECTION 23 38 13

SECTION 23 52 16 – FIRE-TUBE CONDENSING BOILERS

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 packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for heating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.

E. Warranty: Standard warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.

E. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada.

F. CSA Compliant: Boilers shall be compliant with CSA certification.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock.

b. All other components shall carry a one year warranty from date of boiler start up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lochinvar

B. Aerco Benchmark

C. Fulton Endura

2.2 CONSTRUCTION

A. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube

design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu's per tube. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.

C. Condensate Collection Basin: Fully welded 316L stainless steel.

D. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.

E. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 2.4 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 87 gallons.

F. Burner: Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency.

G. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns 20:1.

I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

J. High Altitude: Boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments. High altitude operation shall be certified at a minimum of 4,500 feet above sea level by a third party organization. High altitude boilers shall be certified to 3,000 to 12,000 feet above sea level. The boilers shall carry a CSA certification for high altitude operation up to 12,000 feet.

K. Casing:

1. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.

2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
4. Combustion-Air Connections: Inlet and vent duct collars.

L. Characteristics and Capacities:

1. Heating Medium: Hot water.
2. Design Water Pressure Rating: 160 psi working pressure.
3. Safety Relief Valve Setting: 50 psig

2.3 TRIM

A. Safety Relief Valve:

1. Size and Capacity: 50 lb.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

B. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

C. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

D. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

2.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler controls shall feature a standard, factory installed 8” LCD screen display with the following standard features:

1. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
2. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
3. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
4. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
5. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.

6. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.

7. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.

8. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

C. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

1. Lead lag:

2. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.

3. Front end loading:

4. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

D. Boiler operating controls shall include the following devices and features:

1. Set-Point Adjust: Set points shall be adjustable.

2. Operating Pressure Control: Factory wired and mounted to cycle burner.

3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.

E. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.

2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.

3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

4. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.

5. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.

6. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.

7. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

F. Building Automation System Interface: Factory installed Modbus gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

C. Electrical Characteristics:

1. See Drawings

2. Voltage

a. 120V / 1PH

2.6 VENTING

A. Exhaust flue must be Category IV approved PVC, CPVC, PP or stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend to 100 equivalent feet.

B. Intake piping for all models must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend to 100 equivalent feet.

C. Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.

D. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.

E. Boilers using common venting must contact the factory for sizing.

F. Refer to manufacturer’s Installation and Operations manual for detailed venting instructions and approved manufacturers.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Install equipment on 4” concrete housekeeping pad.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Division 23 Section “Breechings, Chimneys, and Stacks.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   3. Perform field performance tests to determine capacity and efficiency of boilers.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
   6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   7. Notify Architect in advance of test dates.
   8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.

9. Document test results in a report and submit to Architect.

END OF SECTION 23 52 16

SECTION 23 65 00 - COOLING TOWERS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. 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.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

1.2 WARRANTY

A. Warranty:
1. Fan assembly including fan, drive, and motor.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CLOSED-CIRCUIT, INDUCED-DRAFT, COOLING TOWERS

A. Products: Subject to compliance with requirements, provide the following:
1. EVAPCO, Inc. ESWA
2. BAC FXV

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:
1. Casing and Frame Material: FRP with UV inhibitors Galvanized steel, ASTM A 653/A 653M, G235 coating.
2. Fasteners: Galvanized steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

E. Collection Basin:
1. Material: Stainless steel.
2. Overflow and drain connections.
3. Makeup water connection.

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

G. Electric Basin Heater:
1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 3R.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

H. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
1. Pipe Material: PVC.
2. Spray Nozzle Material: PVC.
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

I. Recirculating Piping: PVC.

J. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

K. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
1. Motor Enclosure: Totally enclosed fan cooled (TEFC).
2. Energy Efficiency: NEMA Premium Efficient.
3. Service Factor: 1.15.

L. Heat-Exchanger Coils:
1. Tube and Tube Sheet Materials: Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.

2. Heat-Exchanger Arrangement: Serpentine tubes; and sloped for complete drainage of fluid by gravity.
3. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

M. Drift Eliminator:
1. Material: FRP; with maximum flame-spread index of 25 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

N. Air-Intake Louvers:
1. Material: FRP.
2. UV Treatment: Treat louvers with inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out during all modes of operation including operation with fans off.

O. Axial Fan: Balanced at the factory after assembly.
1. Blade Material: Aluminum.
2. Blade Pitch: Field adjustable.
3. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F Bearings designed for an L-10 life of 40,000 hours.
5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

P. Belt Drive:
1. Service Factor: 1.15 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt: Multiple V-belt design with a matched set of belts.
4. Belt: One-piece, multigrooved, solid-back belt.
5. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
6. Belt-Drive Guard: Comply with OSHA regulations.

Q. Fan Motor:
1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed air over (TEAO).
3. Energy Efficiency: NEMA Premium Efficient.
4. Service Factor: 1.15.

5. Insulation: Class F.
6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
8. Provide independent fan motor for each fan.

R. Fan Discharge Stack: Material shall match casing, design.
1. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
2. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
3. Positive closure dampers with stainless steel linkage

S. Vibration Switch: For each fan drive.
1. Enclosure: NEMA 250, Type 4.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

T. Controls: Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

U. Personnel Access Components:
1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

3.2 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

D. Prepare a written startup report that records the results of tests and inspections.

3.3 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

END OF SECTION 23 65 00

SECTION 23 6 501 – CHEMICAL TREATMENT OF CLOSED CIRCUIT COOLER SPRAY WATER

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submittals shall include manufacturer's data sheets on each piece of equipment and an installation diagram.

PART 2 – PRODUCTS

2.1 All chemicals shall meet and comply with local and state municipality discharge regulations.

2.2 Single biocide to keep microbiological levels within acceptable limits.

2.3 One-drum scale and corrosion inhibitor treatment to minimize corrosion and keep heat transfer surfaces clean and absent of mineral deposits.

2.4 EQUIPMENT

A. Each of the two x 973 gpm closed circuit coolers must be treated individually with a packaged chemical feed unit with the following minimum requirements:

2.5 CONTROLLER

A. Controller shall be a microprocessor based cooling water controller with the following features:
   1. Selectable inhibitor feed timer. Primary feed mode shall be via contacting-head water meter input from below-specified water meter. Controller shall be capable of accepting water meter input and activating the scale and corrosion inhibitor pump for a programmable and adjustable length of time so that chemical is fed in proportion to the makeup water usage.
   2. Dual biocide timers with solenoid pre bleed and bleed lock out.
   3. Flow assembly with flow switch and probe.
   4. HOA operation of all relays.
   5. Automatic temperature compensation.
   6. pH control rising setpoint (temporary pH control may be provided since pH control will only be utilized during passivation stage).

B. The controller shall be a Walchem WCT410 or equal.

C. Controller must be housed in suitable outdoor enclosure along with chemical pumps so as to protect the equipment from the elements.

2.6 WATER METER

A. Contacting head water meter and non resettable totalizing register sized to fit makeup water peak volumes. Each closed circuit cooler has a dedicated 1 ½" makeup water line where water meter must be installed. A SeaMetrics MJR series meter or equal must be provided with a contacting-head feature where 1 pulse= 10 gallons for proportional feed capability.

2.7 CHEMICAL FEED PUMPS

A. Chemical metering pump for corrosion and scale inhibitor shall be positive displacement, electronic diaphragm pump. Output shall be adjustable while pump is in operation. Output volume shall be zero to 10 GPD. Pumps shall be Walchem EZ Series or equal.

B. Chemical metering pump for biocide shall be positive displacement, electronic diaphragm pump. Output shall be adjustable while pump is in operation. Output volume shall be zero to 24 GPD. Pump shall be Walchem EZ Series or equal.

C. Pumps shall be equipped with a three function valve to aid in priming, pressure relief, and anti-siphon.

2.8 BLEED OFF VALVE ASSEMBLY

A. Either of the following valves shall be utilized for bleed-off control:
   1. Motorized ball valve / actuator (Worchester Series 36 or equal)

B. Normally-closed brass solenoid valve with wye-strainer (ASCO or equal)

2.9 TEST EQUIPMENT

A. Solarcult® total aerobic bacteria dip-slide cultures are to be provided for monthly testing (12 total per closed circuit cooler) of bacteria levels in each spray water system. If bacteria counts exceed 10,000 CFU/mL on any of the cultures, prompt remediation is required by the water treatment contractor followed by re-test to ensure bacteria levels have returned to within the 10,000 CFU/mL range.

B. Test kit shall include a portable conductivity meter with calibration standards.

C. Test kit shall include test method and reagents necessary for testing the scale and corrosion inhibitor active ingredient. Kit shall include test instructions and log books with control ranges for each treatment product.

PART 3 – EXECUTION

3.1 GENERAL

A. Water treatment contractor shall be on site to provide instructions to mechanical contractor and owner for equipment installation, systems cleaning/passivation and start up.

B. Water treatment contractor shall submit a confirmation report for verification of galvanized metal passivation for each of the two x 1,945 gpm closed circuit coolers. Report shall contain before and after pictures along with pertinent chemical readings to verify that chemistry has been maintained within the cooling tower manufacturer's recommended limits.

C. All chemical shall be supplied in liquid form in DOT approved containers.

D. Water treatment contractor shall provide twice weekly service and analysis during the first two weeks after start up and a minimum of monthly service for one year from the date of substantial completion.

END OF SECTION 23 65 01

SECTION 23 73 34 - WEATHERPROOF INDIRECT FIRED MULTI-FURNACE GAS MAKE-UP AIR UNIT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work included under this section includes all work necessary for the complete installation of a multi-furnace gas fired make-up air unit.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

PART 2 - PRODUCTS

2.1 Provide make-up air units as manufactured by Captive Aire or approved substitute. These units shall be 83% thermally efficient, with power vented gas furnaces. The units are to be arranged for field duct connections as shown on the drawings.

2.2 The units are to include a centrifugal blower, totally enclosed blower motor, an adjustable belt drive, filter rack with 2" throw away filters, factory installed. Include all required controls, motorized dampers, and inlets to provide required air control cycle. The unit to have full cabinet insulation. Provide rainhood and birdscreen.

2.3 All units shall be equipped for use with natural gas. Unit shall be furnished with a 24 volt control transformer. Gas control system shall be electronically modulating intermittent spark pilot with timed lockout.

2.4 The gas furnace shall contain a heat exchanger of stainless steel, with die-formed burners and drip pan of the same material. Provide required devices for duct with room override temperature sensing system.

2.5 The following accessories shall be provided: roof curb, summer/winter fan control, remote control panel, disconnect switch, motor starter, air flow proving switch, extra set of filters.

2.6 The duct furnace incorporated into the package heating and make-up air units shall be design-certified by the American Gas Association and bear the AGA label.

PART 3 - EXECUTION

3.1 Provide factory authorized personnel for start-up.

3.2 Mount units as indicated on the drawings.

END OF SECTION 23 73 34

SECTION 23 74 13 – 100% OUTSIDE AIR PACKAGE ROOF TOP UNIT

PART 1 - GENERAL

1.1 SUMMARY

A. Provide outside air unit as manufactured by Valent or pre-approved equal.

B. Alternate manufacturers must be pre-approved and shall be subject to compliance with all the requirements listed in this specification.

C. Project is based on the specified equipment. Any additional costs associated with using alternate manufacturer's equipment shall be borne by the installing contractor or equipment provider.

1.2 WARRANTY

A. Unit shall subject to manufacturer's standard warranty for the following periods:

1. Overall unit, 12 months from substantial completion but no more than 18 months from shipment.
2. Compressors, 60 months substantial completion but no more than 66 months from shipment.
3. Enthalpy Core, 60 months from substantial completion but no more than 66 months from shipment.

PART 2 - PRODUCTS

2.1 CASING CONSTRUCTION

A. Unit shall be constructed for outdoor installation on a roof curb, framing, or concrete pad.

B. Base:

1. Base rails shall be constructed of a minimum of 10 gage galvanized steel with 16 gage integral floor pan.
2. Base shall have a minimum 4" overhang over the top of a roof curb to prevent water infiltration.
3. All floor seams shall have a raised rib joint.
4. There shall be no penetrations through the floor of the unit within the perimeter of the curb except for duct openings and utility chases.
5. Penetrations through the floor shall have a ½" raised rib around each opening.

C. Panels:

1. Casing shall be constructed with minimum 2-inch, foam-injected, double-wall panels.

2. Individual panels shall be constructed so that they are thermally broken (there shall be no metal-to-metal contact between the interior and exterior sheet metal of each panel).
3. Interior side of panel shall be 22 gage G-90 galvanized steel.
4. Exterior side of panel shall be 22 gage painted steel rated for 1000 hours in accordance with ASTM B117 and ASTM D1654.
5. Insulation:

    a. Insulation shall be 2 lb/ft3 foam insulation with an average R-value of 6 per inch.
    b. Insulation water absorption must be no more that 0.038 lb/ft per ASTM D 2842 and show "no growth" per ASTM G21 biocide testing.
    c. No insulation shall be exposed to the air stream.
    d. Fiberglass insulation is not acceptable due to possibility of sloughing and moisture retention.

D. Access Doors:

1. Access doors shall be provided for access to all components requiring regular maintenance or inspection.
2. Access doors shall have a minimum of two quarter-turn compression latches with adjustable catches.
3. Access door construction shall be identical to unit casing.
4. Interior side of access doors shall be 22 gage G-90 galvanized steel.
5. Exterior side of panel shall be 22 gage painted steel rated for 1000 hours in accordance with ASTM B117 and ASTM D1654.
6. Access doors shall be sealed with a full-perimeter gasket constructed of Mylar-encased low-density foam.
7. Insulation:

    a. Insulation of shall be 2 lb/ft3 foam insulation with an average R-value of 6 per inch.
    b. Insulation water absorption must be no more that 0.038 lb/ft per ASTM D 2842 and show "no growth" per ASTM G21 biocide testing.
    c. No insulation shall be exposed to the air stream.
    d. Fiberglass insulation is not acceptable due to possibility of sloughing and moisture retention.

E. Weather hood with bird screen shall be provided on outside air inlet.

F. Roof shall be pitched with a minimum ½” roof overhang around the perimeter of the unit.

2.2 BLOWERS/MOTORS

A. Blowers:

1. Fan assemblies shall be direct-drive without the use of belts or adjustable sheaves.
2. Manufacturer shall provide a variable frequency drive for each fan section.
3. Variable frequency drive shall be mounted, wired, and programmed by the manufacturer.

4. Variable frequency drive shall be located in an enclosed compartment outside of the supply or exhaust air stream.
5. Fan wheels shall have backward inclined blades constructed out of corrosion-resistant, fiber-reinforced polyamide.
6. Fan wheel shall be tested in accordance to AMCA 210.

B. Motors:

1. Fan motor shall be VFD rated, ODP type, EPACT compliant.
2. Fan motor shall be of premium efficiency (PE).

2.3 DAMPERS

A. Motorized Dampers:

1. Frame shall be constructed of a 16 gage galvanized steel hat-channel.
2. Blades shall be constructed of 16 gage galvanized steel strengthened by three longitudinal 1 inch deep “vee” grooves.
3. Blades shall be symmetrical relative to its axle pivot point.
4. Axle bearings shall be synthetic sleeve-type and rotate inside extruded holes in the damper frame.
5. Blade seals shall be extruded vinyl permanently bonded to the appropriate blade edges.
6. Frame shall include flexible stainless steel compression-type jamb seals.
7. Modulating spring-return actuators shall be provided by the factory, installed on the damper, and wired to the control center.
8. Damper leakage shall be no more than 3 cfm/sq.ft. at 1 in.wg static pressure.

2.4 FILTERS

A. Outdoor Air Intake Hood:

1. Filter rack shall accommodate 1" media.
2. Manufacturer shall provide 1 set of 1" aluminum filter media.
3. Filter sections shall be accessible outside the unit and located in the outdoor air intake hood.

B. Outdoor Air Filters:

1. Outdoor air filter rack shall accommodate factory-provided 2" MERV 8 filters.
2. Filter sections shall be accessible through a 2" foam-injected, double-wall, hinged access door with quarter-turn latches.

C. Exhaust Air Filters:

1. Return air filter rack shall accommodate factory-provided 2" MERV 8 filters.
2. Filter sections shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

2.5 ENERGY RECOVERY–FLAT PLATE HEAT EXCHANGER, ENTHALPY

A. Energy recovery section shall be an integral part of unit from the manufacturer.

B. No field assembly, ducting, or wiring shall be required with energy recovery option.

C. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

D. Energy recovery shall be provided through a flat-plate air-to-air heat exchanger providing sensible and latent energy transfer.

1. Sensible and latent energy transfer shall occur through the movement of airflow through each side of the heat exchanger. No additional moving parts or drive mechanisms shall be required to enable energy recovery.
2. The heat exchanger frame shall be constructed with 6063 extruded aluminum rails.
3. The heat exchanger media shall be constructed of a polymer membrane with a 0% exhaust air transfer ration (EATR) tested and certified to AHRI 1060-2005.
4. The heat exchanger core shall be capable of handling regular contact with liquid water from either condensation or cleaning.
5. Stainless steel drain pans shall be provided under entire heat exchanger to accumulate and drain condensation or water used in cleaning.
6. The heat exchanger core shall comply with UL 723 and have a flame spread index of 25 or less and a smoke index of 50 or less.
7. Electric preheater shall be provided for frost control on flat-plate heat exchanger.

2.6 COOLING – AIR COOLED DX

A. Unit shall be provided with factory piped, charged, and tested packaged air-cooled direct expansion refrigeration system.

B. Refrigeration system shall include microprocessor-based head pressure control logic to maintain refrigerant pressures by actively modulating condenser airflow (Active Head Pressure Control).

C. Thermal Expansion Valves:

1. Refrigeration system shall be provided with thermal expansion valve (TXV) incorporating adjustable superheat.

D. Evaporator Coil:

1. Coil shall be rated in accordance to ARI standards and pressure tested for 250 psi working pressure.
2. Coil shall be a minimum of 4 rows deep.
3. Refrigeration systems with more than one circuit shall have interlaced evaporator coils.
4. Coil casing shall be constructed of 16 gage galvanized steel casing.
5. Coil tubes shall be constructed of 1/2" diameter, 0.016" thick seamless copper tubing.
6. Coil fins shall be constructed of 0.0060" thick aluminum.

E. Drain Pan:

1. Drain pan shall be constructed of a minimum of 18 gage 201 stainless steel.
2. Drain pan shall be double-sloped to ensure condensate removal from unit.

3. Drain pan shall extend a minimum of 8” past the evaporator coil to ensure condensate retention.

F. Modulating Hot-Gas Reheat:

1. Hot-gas reheat coil shall be separated from the evaporator coil by a minimum of 6” in the direction of airflow to prevent the re-evaporation of condensate, provide room for coil cleaning, and allow control system to monitor evaporator coil leaving air temperature.
2. Coil shall be rated in accordance to ARI standards and pressure tested for 250 psi working pressure.
3. Coil casing shall be constructed of 16 gage galvanized steel casing.
4. Coil tubes shall be constructed of 3/8" diameter, 0.016" thick seamless copper tubing.
5. Coil fins shall be constructed of 0.0060" thick aluminum fins.
6. Hot-gas reheat shall be controlled through a factory-supplied modulating control valve.

G. Compressors:

1. Compressors shall be hermetic scroll type and include the following items:

   a. Suction and discharge service valves.
   b. Reverse rotation protection.
   c. Oil level adjustment.
   d. Oil filter.
   e. Rotary dirt trap.
   f. Short cycling control.
   g. High and low pressure limits.
   h. Crankcase heaters.

2. Compressors shall be installed in an isolated compartment separate from supply airflow, return airflow, microprocessor controller, non-fused disconnect, compressor relays, fan motor VFD, and all other electrical components inside the unit.
3. Compressors shall be installed using manufacturer's recommended rubber vibration isolators.
4. Lead refrigeration circuit shall utilize Digital Scroll™ compressor capable of 10:1 turndown.

H. Condenser Coils:

1. Provide condenser coils with galvanized casing, seamless copper tubes, and aluminum fins.
2. Coil casing shall be constructed of 16 gage galvanized steel.
3. Coil tubes shall be constructed of 3/8" diameter, 0.016" thick seamless copper tubing.
4. Coil fins shall be constructed of 0.0060" thick aluminum fins.

I. Condensing Fans:

1. Condensing section shall be equipped with 1140 rpm direct-drive condensing fans.

2. Condensing fan assembly shall be statically and dynamically balanced in accordance with AMCA Standard 204-05.
3. Condensing fan assembly shall consist of aluminum-bladed propeller fan wheel, formed-channel base, formed inlet venturi, and coated steel basket guard on the discharge.

J. Options:

1. Condensing section shall include factory provided and installed condenser coil guards.

2.7 HEATING – INDIRECT GAS FURNACE

A. Unit shall be provided with AGA-certified, forced-draft, 4:1 turndown indirect gas furnace.

B. Furnace assembly shall include the following items:

1. Electronic modulating gas valve.
2. Two-speed combustion fan.
3. 409 stainless steel heat exchanger.

2.8 ELECTRICAL

A. Units shall be factory wired with a single point power connection.

B. Units shall be wired according to NEC and listed per ETL.

C. ETL listing shall cover all components of the ventilator and not be limited to the control panel.

D. All major electrical components shall be UL listed.

E. Unit shall be constructed with an integral control center isolated from supply airflow, exhaust airflow, compressors, and heating elements.

F. The following items shall be provided and wired within the control center by the factory:

1. Non-fused disconnect.
2. Sub-circuit fusing.
3. Low voltage transformers.
4. Control circuit fusing.
5. Terminal block.
6. Fan motor variable frequency drives.

G. Electrical panel must house all high voltage components such as terminal blocks, variable frequency drives, and fuse blocks.

H. Options:

1. Control panel shall include a factory supplied and mounted 115V GFCI convenience outlet receptacle with a 12A circuit breaker. Outlet shall be powered by [factory, others in the field].
2. Unit shall include a factory supplied, mounted, and wired electric heating element in the control panel to maintain a minimum of 0°F in the panel.

3. Unit shall include a factory supplied, mounted, and wired phase and voltage monitor.

2.9 CONTROLS

A. Units shall include factory supplied, mounted, wired, and tested stand-alone microprocessor controls.

B. Microprocessor controller shall be factory-programmed for discharge air control and use an internal 7-day time clock.

C. Microprocessor controller shall be mounted in a weather-proof enclosure and accessible without exposing the operator to high voltage wiring or having to turn off or circumvent the main disconnect.

D. Microprocessor controller shall include local liquid crystal display (LCD) for user interface.

E. The following sensors shall be factory supplied, mounted, and wired inside the unit:

1. Outdoor air humidity sensor.
2. Outdoor air temperature sensor.
3. Evaporator coil leaving air temperature sensor.
4. Supply air filter pressure monitoring.
5. Energy wheel rotation sensor.

F. The following devices shall be factory supplied but ship loose and require field installation and wiring:

1. Supply air temp temperature sensor.

G. Microprocessor controller shall include BAS communication interface.

PART 3 - EXECUTION

3.1 FACTORY VERIFICATION

A. Unit shall be run tested prior to shipment from the factory.

B. Factory run test report shall be provided at the request of the engineer, contractor, or owner.

END OF SECTION 23 74 13

SECTION 23 81 19 - PACKAGE ROOF TOP UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work included under this section includes all work necessary for the installation of package roof top units.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

PART 2 - PRODUCTS

2.1 PACKAGE ROOF TOP UNITS

A. Furnish and install single zone rooftop units of size and capacity indicated on the drawings. Unit shall be low silhouette, completely assembled including piping and wiring, charged with refrigerant and fully run tested prior to shipment, see section 3.02 (sound). Approved manufacturers shall be Trane, York, Aaon and Carrier. However, the approved manufacturers must meet the requirements contained in this section of the specifications.

B. General - Units shall be dedicated downflow or horizontal airflow as indicated on drawings. Operating cooling range shall be between 0°F and 95°F. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410 and 100 percent run-tested before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Wiring shall be secured to housing of unit in protective raceways or conduit. Units shall be UL listed and labeled. Gas heating unit to be AGA approved.

C. Casing - Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Cabinet construction shall allow for all maintenance on one side of the unit. All panels to be sealed and gasketed air tight. Manufacturer to smoke test final installation to insure units are sealed, and replaced or add gaskets as required. Provide hinged access doors with (2) minimum quick release latches for all service panels. The downflow unit's base pan shall have no penetrations within the perimeter of the curb other than the raised supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting. Insulate all interior surfaces with 1"-3# density fiberglass insulation with antifungal mat facing. Insulate base of unit with foil faced closed-cell insulation.

D. To insure rainwater integrity of the unit, there shall be no electrical wiring penetrating any panel in the evaporator section or any panel of the base of the unit. Provide adequate access for power wiring within curb. Coordinate with electrical contractor.

E. Unit Top - The top cover shall be one piece or where seams exist, it shall be double hemmed and gasket sealed to prevent water leakage and sloped to prevent water standing.

F. Provide factory mounted hinged access doors for filters and controls for all units.

G. Filters - Provide 2" thick, UL Class 1, FARR 30-30 filters for all units unless otherwise specified. Provide filter rack sized for 2" filters access and to permit easy filter removal. The filters shall have non-creased radial pleat design with media support grip and enclosing frame. Filters shall have 30% efficiency based on ASHRAE Test Standard 52-76. Initial resistance shall be 0.08"WG at 250 FPM.

H. Compressors - All 3-10 ton units shall be direct-drive hermetic scroll type compressor(s) with centrifugal oil pump providing positive lubrication to moving parts. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Crankcase heater, internal temperature and current-sensitive motor overloads shall be included for maximum protection. Compressor shall have spring or neoprene isolation and sound muffling to minimize vibration transmission and noise. Provide neoprene for compressors 7-1/5 tons and under. Spring isolators for compressors over 7-1/2 tons.
Units 12½ to 25 ton units shall be direct-drive, hermetic, scroll type compressor(s) with gear type oil pump providing positive lubrication to moving parts. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal temperature and current sensitive motor overloads and crankcase heaters shall be included. Units shall have internal spring isolation and sound muffling to minimize vibration transmission and noise. External discharge temperature limit, winding temperature limit and compressor overload shall be provided. Provide low and high pressure safeties and freeze stats for all units.

I. Refrigerant Circuits - Each refrigerant circuit shall have independent fixed orifice expansion devices, service pressure ports and refrigerant line filter driers factory installed.

J. Evaporator and Condenser Coils - Coils shall be internally finned 3/8" copper tubes mechanically bonded to configured aluminum plate fin. Coils shall be leak tested at the factory to ensure pressure integrity. The evaporator coil and condenser coils shall be leak tested to 200 psig and pressure tested to 450 psig. Provide condenser coil hail guards.

K. Gas Heating Section - The heating section shall have a drum and tube heat exchanger design using corrosion resistant steel components. A forced combustion blower shall supply premixed fuel to a single burner ignited by a pilotless hot surface ignition system. A negative pressure gas valve shall be used that requires blower operation to initiate gas flow. On an initial call for heat, the combustion blower shall purge the heat exchanger 45 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat. Units shall be suitable for use with natural gas or propane (field installed kit).

L. Outdoor Fans - The outdoor fans shall be direct-drive, statically and dynamically balanced, draw through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and have built-in thermal overload protection. Fans to be variable speed for low ambient control.

M. Indoor Fan - The 3-5 ton units shall have a direct-drive, FC centrifugal fan. Units over 5 tons shall have belt driven, FC centrifugal fans with adjustable motor sheaves. Units over 7½ tons shall have an adjustable idler-arm assembly for quick-adjustment to fan belts and motor sheaves. All motors shall be thermally protected. Oversized motors shall be used where high external static pressure is noted on drawings. Provide (1) sheave and pulley, change for each unit if required for air balance.

N. Controls - Unit shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Units shall provide an external location for mounting fused disconnect device. Micro-processor controls shall be provided for all 24 volt control functions, to make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. A centralized Micro-processor shall provide anti-short cycle timing and time delay between compressors. Provide interface for building EMS System. Provide 120V amp 2 plug powered convenience outlet.

O. Roof curbs: All roof curbs shall be of galvanized steel construction with flashings, roof fastenings, and 1" thick fiberglass anti-sweat thermal insulation. Provide sloped curb if required by roof pitch. Roof curbs shall be selected to match the roof conditions. As a minimum, the rooftop air unit base pan must be 12" above the roof, with height of the curb to compensate for roof insulation thickness. Contractor should determine exact height of curb required at each unit location and shall verify roof construction with the architectural drawings and specifications and existing conditions if warranted. Provide field fabricated sheet metal extension between duct from building thru curb to bottom of roof top unit. Do not use curb as plenum.

P. Motorized Outside Air Dampers - Manually motorized set outdoor air dampers shall provide up to 50 percent outside air, see drawings for actual amount. Once set, outdoor air dampers shall open to set position on call for heating and cooling. The damper shall close to the full closed position when request is satisfied. Provide full economizer intake hood with insect screen.

PART 3 - EXECUTION

3.1 The manufacturer's authorized representative shall supervise the mounting, installation, power, start-up and control wiring (including interlocks) and upon job completion notify the Designer in writing that all are operating properly, and are complete and satisfactory in every respect. He shall be responsible for complete start-up and checkout.

3.2 Rooftop units are selected and located by the Designer to produce minimal sound and vibration to the space. Manufacturer to review drawings prior to bidding and notify the Designer if design revisions should be made to accept this unit.

3.3 Provide full 12 months warranty on all parts and labor. Provide a four year extended warranty (parts only) on compressor, evaporator and condenser coils, fan motors and controls.

3.4 The weight of the unit shall be equal to or less than the unit scheduled on the drawing.

3.5 Verify prior to bidding that the units meet the electrical characteristics shown on the drawings. This includes voltage, full load amps and disconnect (as shown on electrical drawings). The successful manufacturer shall notify the contractor the size of his required disconnect.

3.6 FILTER MEDIA FILL

A. Provide initial filter media fill as described hereinbefore for each filter of each type installed for testing and adjusting AC system and left in place for Owner’s immediate use.

B. Provide one complete fill and each filter of each type for Owner’s future use. Store all media on premises in factory sealed containers, at a location as directed by the Owner’s authorized representative. Obtain a signed receipt for these filters and include in project close-out documents.

END OF SECTION 23 81 19

SECTION 23 81 26.1 - DUCTLESS SPLIT SYSTEM UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work required under this section includes all work necessary for the complete installation of ductless split system units.

B. The work of this section is subject to the requirements of the Mechanical General Provisions and Basic Material Specifications.

1.2 SUBMITTALS

A. Provide drawings indicating dimensions, rough-in connections, electrical characteristics, unit performance, agency listings, and connection requirements.

B. Provide manufacturer's installation and start-up instructions.

C. Provide manufacturer's color selection charts.

D. At job closeout, provide manufacturer's installation, operation, and maintenance data along with product warranty certificate.

1.3 WARRANTY

A. Provide one year warranty on all unit parts and a five year warranty for refrigeration compressors.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install where shown on plans, ductless split system units of sizes and capacities shown on the schedule. The units shall include the indoor evaporator section and the outdoor condenser section. Approved manufacturers shall be EMI, Mitsubishi, and Sanyo.

2.2 WALL HUNG EVAPORATOR SECTION

A. Provide wall hung heat pump units with back-up resistant heat as shown on schedule. Provide hanger brackets and or trim kits as applicable.

B. Cabinet shall be constructed of cold roll steel, with structural stiffeners and powder coated finish. Inlet panel construction of high impact polstyrene with perforated steel inlet grille.

C. Discharge grille shall be high temperature Noryl with adjustable vanes.

D. Condensate drain pan shall be galvanized steel with anti-corrosion coating.

E. Fan shall be tangential type, directly mounted to the motor shaft. Motor shall be PSC type with overload protection.

F. Filter shall be permanent, washable, and user accessible.

G. Coil shall be seamless copper tubing, arranged in staggered configuration, with enhanced aluminum fins, tested to 460 PSIG. Tubes shall be mechanically expanded for secure bonding to fin shoulder. Connections are sweat type.

H. Controls shall include relays and connections for condensing unit.

1. Unit mounted controls with thermostat, fan speed control, and heat/cool switch.

2.3 CONDENSER SECTION

A. Provide a single zone condensing unit with 4-way reversing valve, solenoid activated by 24V, energized for cooling operation. Provide unit with a TXV with internal check valve to provide proven operation through all temperature ranges in heat pump mode.

B. Cabinet shall be constructed of G-60 galvannealed steel, finished with corrosion inhibiting, high-gloss, powder coated. Fan guard shall be heavy-gauge, vinyl dipped wire, or stamped integral to cabinet.

C. Compressor shall be hermetically sealed, high efficiency type. Motor shall be PSC type with internal overload protection. Compressor shall be installed on resilient mountings. Minimum unit SEER shall be 10.0 and minimum COP = 2.8 in reverse cycle heating mode

D. The condensing unit and evaporator section shall be precharged with refrigerant. Unit refrigeration valves shall be solid brass for sweat connection.

E. The condenser coil shall be seamless, copper tubing, arranged in staggered configuration, with enhanced aluminum fins. The tubes shall be mechanically expanded for secure bonding to fin shoulder.

F. The condenser fan shall be a high efficiency propeller type, directly connected to the totally enclosed PSC motor. The motor shall be internally and thermally protected. The condensing unit shall be draw-through design.

G. System options shall include low ambient operation to 0 degrees F. Other system options shall be as noted on schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit in accordance with manufacturer's recommendations.

B. Verify prior to bidding that all units meet all electrical characteristics shown in the contract documents. This shall include voltage, phase, full load amps, and overcurrent protection. Coordinate exact electrical requirements with the electrical contractor prior to rough-in.

END OF SECTION 23 81 26.1

SECTION 23 8 1 56 - HEAT PUMPS

PART1 - GENERAL

1.1 WORK INCLUDED

A. The work necessary under this section includes all work necessary for the installation of geothermal water to air heat pumps.

B. The work of this section is subject to the requirements of the Mechanical General Provision and Basic Materials Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Basic Materials and Methods, Section 230510.

B. Insulation, Section 230700.

C. Geothermal Closed Loop Heat Exchanger, Section 232115.

D. HVAC Piping, Section 232113.

E. HVAC Pumps, Section 232123.

F. Air Distribution, Section 233000.

G. Controls and Instrumentation, Section 230900.

PART 2 - PRODUCTS

2.1 WATER TO AIR HEAT PUMPS

A. General:

1. Furnish and install packaged water source heat pump units of type, size, and capacity shown on the equipment schedules. Unit performance shall be certified in accordance with ARI/ISO Standard 13256-1 for Geothermal Water Source Heat Pumps.
2. Equipment schedules and specifications are based on Waterfurance, Florida Heat Pump, Climatemaster or as approved by the Engineer. Scheduled EER and COP are minimums required at ARI/ISO 13256-1 standard conditions.
3. Units shall be of the horizontal or vertical type as shown on the drawings and consist of a fan, indoor (evaporator) coil, compressor, four-way valve, and water-to-refrigerant heat exchanger with necessary controls in a factory assembled package.
4. Unit shall have a sound insulation package incorporating 3/4", 1.5lb density acoustic fiberglass on the entire unit.

B. Refrigerant Circuits:

1. Units shall include factory assembled refrigeration circuits consisting of a hermetic motor-compressor with internally fused capacitor (except on three-phase units), air-to-refrigerant finned tube coil, thermal expansion valve, pilot operated refrigerant reversing valve, water-to-refrigerant coaxial tube exchanger, high side and low side access valves and high pressure and low water temperature safety cutouts factory installed on the refrigeration circuit.

2.2 REFRIGERANT COILS

A. General: Coils shall be aluminum plate fin and copper tube type. Fins shall have collars drawn, belled, and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing shall be mounted in the coil casing to be accessible for service, and can be taken from the unit through removable panels. All coils are to be ARI Certified. The coil tubes shall have a minimum thickness of not less than 0.024". The coil fins shall have a minimum thickness of not less than 0.009".

B. Refrigerant Cooling coils: All coils shall be enclosed in an insulated coil section. Refrigerant coils shall have an equalizing type vertical distributor to insure that each coil circuit receives the same amount of refrigerant liquid. Coils shall be tested at 300 psig air pressure under water, then cleaned, dehydrated and sealed with a holding charge of dry nitrogen to 10 psig.

C. Evaporator Coil: Indoor (evaporator) coil shall be constructed with an aluminum plate fins mechanically bonded to non-ferrous tubing with all joints braxed. Factory installed refrigerant control shall be provided.

D. Heat Exchanger: Heat exchanger shall be a circular tube-in-type with a steel outer tube and copper integral finned inner tube. Maximum operating working pressure shall be 300 psig.

E. Compressor: Compressor shall be of the welded hermetic type suitable for heat pump duty with internal vibration isolation. Compressor motor power input shall not exceed specified KW at specified conditions as shown on the schedules. Unit shall have a five minute antishort cycle timer relay to prevent compressor cycling.

F. Fans:

1. The fan shall be the centrifugal forward-curved blower type with double inlet, mounted on a motor shaft, dynamically and statically balanced. The fan shall deliver the cfm and external static pressure as indicated on the schedules. Fan motors shall be factory lubricated.

G. Accessories:

1. Filter shall be of the 1" thick pleated replaceable media type. Filter and filter frames shall be provided with the unit by the manufacturer for installation on the inlet.
2. Unit manufacturer shall provide combination balance and shutoff valve for water return line and gate shutoff valve for water supply line, shipped loose for installation by the Contractor. Hose kits for vertical and horizontal units shall be galvanized braided.
3. Control cabinet, sensors, step controllers, relays, etc., as described in control description.
4. Unit manufacturer shall provide fused motor starters with heat pumps and shall be wired under Division 26 with a single point electrical connection.

H. Controls:

1. Refer to controls sequence of operations on drawings.

I. Factory Start-up:

1. Manufacturer shall provide factory check-out and start-up of each unit. Upon completion of installation, and receipt of readiness report from Contractor, the manufacture shall provide supervision for start-up.
2. Upon completion of start-up, a report shall be submitted to the Architect for approval.

J. Standard One-year Warranty: Units shall be warranted against any and all defects in material and workmanship for a period of one year from date of original installation. This warranty covers repairs or replacement of defective parts which shall be returned, transportation charges prepaid, to manufacturer for examination and determination as to liability.

K. Extended Four-year Compressor Warranty:

1. Provide an additional four-year warranty on the compressor only. This additional four-year warranty becomes effective upon the expiration date of the standard warranty listed above and is limited to replacement of a defective compressor only. Specifically excluded are: loss of refrigerant, electric controls, relays, pressure controls, fan and motor assemblies, and connecting refrigeration tubing or electrical wiring.
2. Excluded is any part of the compressor which becomes defective as a result of negligence, Owner's failure to provide normal maintenance, improper repair or alteration.
3. Excluded also is field labor costs for removal of compressor, transportation to exchange agency, and installation cost.

PART 3 - EXECUTION

3.1 Install units per manufacturers specification and instructions.

3.2 Provide vibration isolation.

3.3 Provide filter box at unit return to completely enclose, air tight, the filter and with a rack for easy filter removal. Provide a access door with piano hinge and camlock latch.

END OF SECTION 23 81 56

SECTION 26 00 00 – GENERAL ELECTRICAL

PART 1 - GENERAL

1.1 OTHER CONDITIONS

A. Applicable provisions of the General conditions, Supplementary Conditions, and Division 1, General Requirements, apply to the Work under this Section.

1.2 SCOPE OF WORK:

A. The work included under this specification consists of, but is not limited to, work as indicated on the drawings and hereinafter specified in Division 26. Without limiting the generality implied by the drawings an specifications, electrical consists of furnishing all materials, accessories, tools, and labor required and incidental thereto, to provide:
1. Lighting fixtures and lamps.
2. A complete system of conduit and conductors to supply electricity throughout the building addition.
3. Panelboards, switchboard, wiring devices, safety switches, dry type transformers.
4. Temporary wiring to be used during construction.
5. Wiring in connection with heating, ventilating, plumbing, and air conditioning equipment.
6. Emergency lighting.
7. Raceway facilities for communications systems.

1.3 RELATED WORK:

A. Division 21: Fire Suppression, Division 22: Plumbing; Division 23: Mechanical; Division 27: Communications; Division 28: Electronic Safety and Security.

B. See drawings and other sections for equipment requiring electrical service.

C. Painting (except factory-applied finishes on equipment) is specified elsewhere.

1.4 REFERENCE STANDARDS:

A. Make entire electrical installation in strict accordance with the requirements of all city, county, state, or federal codes of law having jurisdiction, the requirements and recommendations of the Board of Fire Underwriters, including all amendments and/or additions to said codes, laws, requirements, and recommendations and the requirements and recommendations of the Power Company. Applicable codes are as follows:
1. 2006 NFPA 101 Life Safety Code.
2. 2003 NFPA 72
3. 2008 NFPA 70
4. 2002 NFPA 90A
5. 2005 NFPA 92A
6. 2002 NFPA 13

7. 2002 NFPA 13R
8. 2002 NFPA 13D
9. 2003 NFPA 14
10. 2006 International Building Code
11. 2006 International Fire Code
12. 2006 International Mechanical Code
13. 1999 NFPA 20

B. Should any work shown on the drawings or herein specified be construed a being contrary to or not conforming to the previously mentioned Codes, etc., bring it to the attention of the Architect before executing the work in conformity with the various codes,etc., without additional cost to the Owner, but not until the matter in question has been reviewed by the Architect.

C. Should any work shown on the drawings or herein specified be more rigid as to requirements than the requirements of the various codes, the drawings and specifications shall be used in executing the work.

D. File with proper authorities all necessary drawings as required by various codes, laws, ordinances, or other requirements.

E. Obtain and pay for all permits and for all required inspection certificates. Pay necessary fees.

1.5 WARRANTY-GUARANTEE

A. Warrant and guarantee that all work executed under this section of the specifications will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of the building. The above parties further agree that they will, at their own expense, repair and replace all such defective work and all other work damaged thereby which defective during the term of the warranty-guarantee.

1.6 ARCHITECTURAL DRAWINGS:

A. Refer to architectural drawings for details such as finishes, dimensions, materials, etc. Refer to drawings for door locations, door swings, partitions location, cabinet and counters, making proper allowances therefore. Refer to equipment plans for exact location of electrical connections which are dimensioned.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. Manufacturer's Data: For information only, submit 6 copies of manufacturer's specifications, descriptions, illustrations, and installation instructions for each type of manufactured product to include: Lighting fixtures, lamps, exit signs, wiring devices, and switchgear intended for use on this project. The submittal

shall consist of one or more brochures each containing only "one" copy of material describing the product. Several products may be included in each brochure.

B. Include manufacturer's certification as may be required to show compliance with these specifications. Indicate by transmittal form that a copy of each instruction has been distributed to the installer.

C. Furnish three complete sets of operating and maintenance instructions applying to equipment installed in conjunction with this contract; include parts lists, wiring diagrams, catalog data, stamped approval submittal data, and operational checkout data as called for in these specifications, bound in hardback binders. Instructions shall be submitted to the Architect for approval at least one month in advance of initial system start-up.

2.2 PRODUCTS

A. Materials shall not be ordered until architect's review of submittal material has been made. They shall be new and unused and the manufacturers standard product and the latest designs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The electrical drawings which show the work included are diagrammatic only; the locations, routing, etc., of the various fixtures, items of equipment, wiring, etc., are approximate only. The entire installation is subject to such deviations, modifications, rerouting, etc., as may be necessary to meet the requirements of the architectural, structural, and other drawings; and also as necessary to obtain a proper coordination of the work with that of all other trades.

B. Carefully check and become familiar with the above-mentioned drawings, and frequently consult with all other trades so that the work may proceed as a harmonious whole.

C. Install concealed all wiring except where the Architect grants specified permission to run same exposed.

D. Installer shall defer the installation of all electrical fixtures liable to damage. After fixtures are permanently installed, completely protect against breaking, damage, or the depositing of any waste material therein until the system is accepted.

3.2 COORDINATION

A. Carefully check locations, layouts, and dimensions of all items to be installed under this section with the above-mentioned drawings, and coordinate with all trades affected.

B. Any work installed without properly checking and coordinating same as above provided, which as a result interferes with the proper installation of the work of other trades, is to be removed and properly reinstalled without additional cost to the owner.

C. It is the installer's responsibility to notify well in advance, all trades affected, or any chases, recesses, etc., which may be required for the installation of the electrical work. Should this be neglected, any cutting and/or patching required for such chases, recesses, etc., to be done at this contractor's expense.

D. Carefully examine all architectural, structural, plumbing, heating, electrical, and other drawings; and all other sections of the specifications for items, equipment, etc., not a part of the electrical contract which may require electrical connections. Unless explicitly indicated to the contrary, furnish and install all necessary electrical lines, boxes, etc., and make final connections to all such items, equipment, etc.

3.3 PROTECTION AND CLEANING

A. Protect work, fixtures, and materials at all times. Tightly cover and protect equipment against dirt, water, chemical, or mechanical injury. At final completion of all work to be thoroughly cleaned and delivered in a perfect unblemished condition.

B. Touch-up all damaged paint surfaces on equipment to match original paint.

3.4 TEMPORARY WIRING

A. As soon as practicable, install temporary wiring and lighting throughout the building addition. There shall be one pigtail lampholder for each 600 square feet of floor space or fraction thereof and in addition install a plug receptacle for each room having at least 200 square feet of space. There shall be one light in each room of 50 square feet or larger. Each pigtail outlet shall be equipped with a 100-watt lamp and replacement made immediately upon burnout or theft. Locate lights, as per above, on 25 feet center; install a temporary panelboard with not more than eight outlets, lights or receptacles on a circuit. Temporary wire shall consist of plastic type non-metallic sheathed cable having a ground wire to which all the receptacle ground poles shall be connected. Receptacles shall have "ground-fault" protection.

3.5 WORK IN CONNECTION WITH MOTORS

A. Check rotation and connect for proper rotation. Check overload heater element furnished with starters against nameplate rating or motor and code, call

attention to improper sizes to mechanical contractor and architect. Connect all motors with short length of flexible conduit. Connect all pump motors with "UA" type flexible conduit as manufactured by American Brass Co. Use proper type connector with the type conduit. Connect all motors and controls completely, neatly, orderly, and properly tagged to proper operation of system involved. Motor connection not required unless specifically shown.

3.6 WORK IN CONNECTION WITH THE MECHANICAL AND PLUMBING EQUIPMENT

A. Furnish and install all conduit and wiring necessary for the line-voltage power supply (120-volts and above) of plumbing and heating, ventilating and air conditioning equipment. Furnish and install disconnect switches with the motors where required by the Code. Refer to the plumbing, heating, and air conditioning drawings and specifications. Control wiring for HVAC equipment shall be a part of Division 23.

3.7 SERVICE TO EQUIPMENT

A. Check service required by equipment prior to making final connections. Call differences to attention of Architect. Check equipment for proper protective devices and safety devices to allow proper operation of equipment and prevent burnout. Assist Owner in initial operation of equipment and make necessary adjustment for proper operation.

3.8 INITIAL OPERATION OF EQUIPMENT

A. Give all equipment furnished in the contract an operational test prior to final acceptance. Assist the Owner in the initial operation when the owner operates the building and equipment. Instruct the owner's personnel in the proper operation and maintenance of all the equipment furnished under this section of the specifications.

3.9 PROTECTION OF ROOF

A. Coordinate electrical work with roofing work in regard to any electrical items which may pierce or otherwise affect the roof. Hold consultation well in advance of the installation of the final roofing and allow sufficient time for the roofing work to be prepared for the electrical work.

B. Arrange for any cutting or repairing to roofing which might already be installed when an electrical installation is made. See roofing specification for roofing with relation to work of other trades piercing the roof. If necessary consultation is not held, any roof repairs necessitated by the electrical installation shall come under the scope of the work under this section.

3.10 FIRE-RATED WALL PENETRATIONS

A. Where conduit penetrates fire-rated walls, the space between the penetration item and the fire barrier wall shall be properly protected. The space adjoining the conduit penetration shall be filled with a material capable of maintaining the fire rating of the fire barrier, or it shall be protected by an approved device designed for this specific purpose. Where penetrating sleeves are used, the sleeves shall be solidly set in this fire barrier wall, and the space between the conduit and the sleeve shall be filled with a material capable of maintaining the fire resistance of the fire-rated wall.

END OF SECTION 26 00 00

SECTION 26 01 00 - EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide identification for electrical equipment as set forth hereinafter.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Products shall be as set forth in other sections of specifications.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Furnish and install engraved, laminated phenolic nameplates for all safety switches, panelboards, transformers, switchboards, motor control centers, and other electrical equipment supplied for the project for identification of equipment, controlled, served, phase, voltage, etc. Nameplates shall be securely attached to equipment with self-tapping, stainless steel screws and shall identify equipment controlled, attached, etc. Letters shall be approximately ½" high, minimum. Embossed, self-adhesive plastic tape is not acceptable for marking equipment.

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

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

END OF SECTION 26 01 00

SECTION 26 02 00 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Provide supports for raceway systems as described hereinafter.

PART 1 - PRODUCTS

2.1 MATERIALS:

A. Products shall be as set forth elsewhere in these specifications.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Conduit shall be supported in a method and at a spacing as approved by the NEC, except as described herein.

B. Conduit shall be supported by approved pipe straps or clamps.

1. Conduit installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of ¼" using "clamp backs" or strut.

2. Pipe straps or clamps shall be secured by means of:

a. Toggle bolts on hollow masonry.

b. Metal expansion shields and machine screws, or standard preset inserts on concrete or solid masonry.

c. Machine screws or bolts on metal surfaces.

d. Wood screws on wood construction.

END OF SECTION 26 02 00

SECTION 26 03 00 – POWER SERVICE AND GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Power service to the building shall be taken underground at 480/277-volts, 3-phase, 4-wire, wye, from utility company padmounted transformer, as illustrated on drawings and called for hereinafter.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Products for power service shall be covered under other sections of the specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide grounding of service as set forth hereinafter. Provide two sets of four driven 5/8” x 10’ long copperweld ground rods, each group separated from one another by a minimum distance of 15’. Each ground rod shall also be separated by a minimum distance of 15 feet. From each group of rods, extend a #3/0 AWG bare copper grounding conductor to main service entrance disconnect switch and bond to neutral and ground bus. Bonding connections at ground rods shall be by Cadweld process. In addition, extend a #3/0 AWG bare copper grounding conductor and bond to main metallic cold water pipe where it enters building. Ground by direct connection all interior metal piping systems. Ground structural steel in building foundation to main electrical ground with a #3/0 AWG copper grounding conductor.

B. Furnish and install a code-sized equipment grounding conductor in all feeder and branch circuit conduit runs. Code-sized grounding conductor is generally not indicated on drawings but shall be required. Ground equipment and lighting fixtures in accordance with National Electrical Code.

C. Ground dry type transformer, see detail on drawings for requirements.

D. Power outages necessary for completion of contract work shall only be permitted at times approved well in advance by architect/owner. Necessary outages shall be kept to absolute minimum time needed for work.

END OF SECTION 26 03 00

SECTION 26 05 13 - 15 KV CONDUCTORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Primary cable shall be shielded 15 KV 133% single conductor, copper, insulated with ethylene-propylene rubber insulation, with a polyvinylchloride jacket overall. The cable shall be rated 105º C for normal operations, 140º C for emergency overload operation, and 250º C for short circuit conditions. Cable shall be CT rated.

B. Provide deadbreak separable splices, load break elbows, and cold shrinkable metallic shield kits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Requirements: The cable furnished under this section of the specification shall be rated for operation at a nominal 15 KV. The cable shall be suitable for normal installation, indoors or outdoors, in air, conduit, or direct buried, and shall be suitable for intermittent or continuous submersion in water. Approved manufacturers for 15-KV cable are Okonite Company and Kerite Company. No other substitutions allowed. Approved manufacturers for connectors are 3M Corporation and Cooper Power Systems.

B. Conductors: The cables supplied under this specification shall have uncoated soft annealed copper conductors in accordance with ASTM B-8. The conductor sizes shall be No. 4/0 AWG.

C. Conductor Screen:
   1. The conductor screen shall be an extruded layer of semiconducting EPR thermosetting compound shall have a minimum elongation after an air oven test at 121o C for 168 hours of 100% and a brittleness temperature not warmer than -50o C.
   2. The conductor screen shall be clean stripping from the conductor and inseparably bonded to the overlying insulation.

D. Insulation:
   1. The primary insulation shall be 15 KV voltage class, ethylene-propylene rubber (133% insulation level), 220 mils.
   2. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight of ethylene nor shall the insulation compound contain any polyethylene, both features to limit the degree of susceptibility to treeing experienced by highly crystalline materials. The insulation shall be compounded by the cable manufacturer in its own facility using a closed system to insure maximum cleanliness. All will be mixed, screened through a 120 mesh screen pack and then treated with the accelerator or crosslinking agent to insure complete blending and uniformity of the final compound.

3. The insulation shall be triple-tandem extruded with the conductor screen and insulation screen to prevent intersurface contamination, and to permit accurate measurement of each layer of compound during manufacturing.

E. Insulation Screen:
1. The nonmetallic insulation screen shall be a thermoset layer of semiconducting ethylene-propylene rubber with a volume resistivity not in excess of 10 ohm-meters at 105o C when tested in accordance with AEIC CS6-87 and ICEA S-68-516.
2. The insulation screen shall be clean stripping from the insulation with a peel strength in accordance with AEIC CS6-87.

F. Metallic Shield: The extruded semiconducting screen shall be covered with a five mil uncoated copper tape. It shall be applied helically with a 25% nominal overlap.

G. Overall Jacket: A continuous extruded jacket of moisture, heat, oil, and abrasion resistant black polyvinylchloride (PVC) meeting or exceeding the requirements of ICEA S-68-5167 shall be applied over the metallic shield. The minimum thickness at any point shall not be less than 80% of minimum average value.

H. Warranty: Cable shall have twenty-five (25) year warranty from date of shipment by seller to purchaser.

I. 15-KV Termination:
1. Termination kits shall be capable of properly terminating a 15-KV single conductor polymeric-insulated cable. Kits shall meet Class I requirements and be design-proof tested per IEEE 48-1975 and be capable of passing a test sequence per draft and revisions of IEEE 404-1986. Kits as specified shall accommodate any common form of cable shielding/construction without the need for special adaptors or accessories, and shall accommodate a wide range of cable size and, also, be capable of being properly installed on out-of-round or out-of-tolerance cable as per relevant IDEA standards. Kits shall accommodate commercially available connectors.
2. Terminations for single-conductor cable shall consist of cold shrink stress control and outer non-tracking insulation tubes along with high relative permittivity stress relief mastic for insulation shield cutback treatment with a cold shrink sealant for environmental sealing. Outdoor terminations shall include rain shields.
3. Termination kits shall be manufactured by 3M Corporation, Cooper.
4. All loadbreak elbows shall be equipped with peroxide-cured EPDM insulation, copper top connector, tin plated copper loadbreak probe with an ablative arc-follower tip, stainless steel reinforced pulling eye, and capacitive test point. Provide amperages as indicated on drawing, Cooper RTE or approved equal.
5. Deadbreak separable splices shall be equipped with peroxide-cured EPDM insulation, capacitive test points, and shall meet IEE Standard 386 for separable insulated connector systems. Provide splices as indicated on drawings, Cooper SSPL series or approved equal.
6. All 600A connector plugs and 200/600A. loadbreak adapters shall be EPDM insulation only.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Factory Testing:
   1. Each insulated conductor provided under this section of the specification shall be tested in strict accordance with Section E of AAEIC CS6-87.
   2. A certified copy of actual production test values for the cable provided under this section of the specification shall be provided, including the AEIC partial discharge corona test X-Y plot.

B. Cable furnished under this section of the specification shall be installed, spliced, and terminated in accordance with the written instructions and recommendations of the cable manufacturer. The Owner shall assist Contractor in splicing 15-KV conductors in manholes.

C. Field Quality Control Testing: A high voltage DC test shall be performed in accordance with Section 2M, Testing.

D. Submittals:
   1. At time of bid submit product data along with a statement of compliance with the requirements of these specifications from the cable manufacturer.
   2. For approval, submit to the engineer prior to shipment the data in Paragraph A along with a copy of Qualification Tests as specified in AEIC CS6-87, Paragraph L.
   3. For approval prior to installation, submit to the engineer the factory test results as specified in Paragraph 3.a.1.

E. Testing:
   1. All cable shall be tested prior to connection to the campus 13-KV power source. Testing shall include the following: (a) Each of the cables shall be megger tested prior to connecting to the elastimold connectors. After all connectors have been made and prior to connecting to the building service or to the power source, they shall be again meggered with a 1,000-volt megger, and if tested to be sound, a high potential test shall be performed. (b) The high potential test shall be by a recognized testing agency and shall impose a potential on the cable not greater than that recommended by the cable manufacturer. Each phase conductor of each line shall be tested independently prior to connection to the University Campus 13-KV power source. Testing agency shall be totally independent of contractor.
   2. A certified record shall be made of the test results with megger readings recorded and a record of the type test performed for the high potential test shall be certified. In addition, a megger test shall be performed to determine the resistance level of the conductor insulation.
   3. Test shall conform to IPECA Standard No. S-66-524.

F. Power Outages: Power outages will be necessary for connection of new lines, disconnection of existing lines, etc. All power outages shall be carefully planned and

scheduled with TSD. Contractor shall assume that all power outages will be held at odd hours in the morning, and on weekends or holidays. Time shall be as specifically directed by TSD.

END OF SECTION 26 05 13

SECTION 26 05 19 – LOW VOLTAGE, 600 VOLT CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conductors throughout the raceway system and distribution of electrical energy for the lighting, and power, and control needs.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use stranded conductors with spade type terminal ends. Minimum size shall be No.12 AWG. Insulate conductors with Type "THHN/THWN" insulation unless specifically indicated otherwise on the drawings. Rating shall be 600-volts, AC.

B. Connectors for conductors size No. 10 and 12 shall be approved type insulated twist-on wire nuts. Use hydraulic compression type connectors for conductors No. 8 and larger.

C. All conductors are to be copper.

D. Metal clad (MC) cable shall be permissible for use for final connection to lay-in fluorescent lighting fixtures from junction box, provided that length of each respective run of MC cable does not exceed six (6) feet. Otherwise, MC cable shall not be utilized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to manufacturer's recommendations and latest standard practice of industry. Color code all conductor for phase, neutral, and ground reference, as follows:

PHASE	208/120v.	480/277v.
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Natural Gray
Ground	Green	Green

END OF SECTION 26 05 19

SECTION 26 05 33 – RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install a system of raceways and boxes for installation of conductors for distribution of power and controls throughout building. Conduit shall be concealed except where specifically called for to be exposed, such as in mechanical/electrical equipment rooms.

B. Furnish outlet boxes for lighting fixtures, wall receptacles, switches, and other boxes as required. Also, pull boxes and junction boxes shall be furnished as required.

1.2 REFERENCES

A. General Provisions of the Contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Underground wiring on exterior of building shall be Schedule 40 polyvinyl chloride (PVC). Schedule 40 PVC shall also be permissible for underground wiring runs inside the building, with galvanized rigid steel elbows utilized where conduit turns up through floor slab.

B. Galvanized rigid steel conduit shall be utilized for all exposed conduit on the exterior of the building.

C. All overhead conduit lines inside building shall be in metal raceway. Electric-metallic tubing (EMT) shall be used for all overhead wiring inside the building, unless specifically prohibited by NEC.

B. Minimum size conduit on project shall be 1/2".

2.2 BUSHINGS

A. Bushings for conduit 2" in size and smaller shall be plastic. Conduit size 2-1/2" and larger shall be OZ Company type "B" Appleton Co. Efcor Series NO. 55 or approved equal with metal ring and insulator as an integral part of bushing.

2.3 CONDUIT COUPLINGS

A. Conduit couplings (EMT) shall be compression type.

2.4 FLEXIBLE CONDUIT

A. Flexible metal conduit shall be used for final connections for all motors, transformers, unit heaters, lighting fixtures, and other permanently connected equipment. Maximum length of flexible conduit shall be 24" except for connection of light fixtures, which may have a length of up to 72". The flexible conduit shall be constructed of hot-dipped galvanized, interlocked spirally wound steel strip. All connectors shall be galvanized and shall be listed for connection to the conduit and boxes. Provide a ground conductor in each length of flexible conduit. Flexible conduit used in mechanical rooms, kitchen areas, and damp or wet locations shall be liquid tight. Other than the uses listed above, the use of flexible conduit will not be permitted. The use of "MC" will not be considered.

2.5 MANUFACTURER

A. Conduit shall be as manufactured by Pittsburgh, National, Republic Steel Companies, General Electric Company, or approved equal.

2.6 CEILING BOXES

A. Ceiling outlet boxes shall be 4-inch octagon and 2-1/8 inch deep. Provide extension rings where additional volume is required. All ceiling outlet boxes shall have fixture stud of no-bolt, self-locking type installed if required to hang fixture specified at that outlet.

B. Where ceiling outlets occur in reinforced concrete, provide rings with removable back plate and fixture stud specifically designed for this purpose.

2.7 WALL BOXES

A. Light wall switch boxes shall be a minimum size of 4" high by 2-1/8" wide by 2-1/8" deep. Where more than one gang occurs, 4" square boxes or additional larger boxes shall be used with device ring attached. Boxes in masonry shall be 4" high and 2-1/2" deep with the number of gangs necessary. An example of the masonry box shall be Raco Co. No. 692 for 3-gang, No. 693 for 4-gang, etc.

B. Plug receptacle boxes shall be 4" square by 2-1/8" deep with a 4" square device cover, either one or two-gang as required. Covers shall be square cut, with a depth to accommodate the wall finish material with a minimum raised cut of 1/2".

C. Provide special sized boxes where called for on the drawings. In MRI Areas, all boxes shall be cast aluminum “bell boxes”.

2.8 MANUFACTURER

A. Boxes and fittings shall be Appleton, Steel City, Raco, Efcor, Crouse-Hinds, or equal.

2.9 FABRICATION

A. Pull and junction boxes shall be galvanized or sherardized sheet metal or code thickness with lapped and welded joints and with 3/4" flange. They shall be rigidly supported on ceiling or wall. Conduit runs entering a box shall not be considered as adequate support.

PART 3 - EXECUTION

3.1 ROUTING REQUIREMENTS

A. Drawings illustrate diagrammatic wiring routings. It shall be the responsibility of the electrical subcontractor, working in conjunction with the general contractor, to coordinate routings of all wiring runs with other trades.

B. Drawings specifically illustrate where wiring is to be run overhead and underground. While the routings shown are diagrammatic, contractor shall adhere to running wiring overhead where shown run overhead inside building on drawings, unless specific permission is granted otherwise.

3.2 INSTALLATION

A. Protect threads on rigid conduit during storage. To prevent entry of moisture and foreign matter in conduit during construction, install factory made conduit caps on conduit stubs. Swab conduit runs clean and dry prior to pulling wire.

B. Cut conduit square, ream smooth, and thread properly and fully. Paint job cut male threads with conductive lead paint prior to making up a threaded conduit joint.

C. Conduits shall be continuous from outlet to outlet and from outlet to panel or pull box. Connect conduit in building construction except as indicated. Secure conduit to all boxes and bushings with double locknuts so that system will be electrically continuous.

D. In concrete slabs, block up conduit from forms and securely fasten in place. All conduits in slabs shall have a minimum of 2 inch concrete coverage above and below.

E. Where conduit is installed in poured concrete slabs and it crosses an expansion joint, an expansion fitting equal to OZ type "AX" with a bonding jumper type "AL" shall be installed. Use Crouse-Hinds, Appleton, or approved equal.

F. Install all conduit in a workmanlike manner with bends made using tools specifically designed for purpose to prevent kinks and flattened areas. Where

electric metallic tubing is connected to an outlet box or panel, terminate tubing in an approved type connector and couple together with approved type connectors in order to insure adequate bonding.

G. Where conduit is installed above ceilings, secure it in place by attachment to building structural framing system with appropriate clamps manufactured for purpose of making conduit attachment.

H. Where conduit pierces a rated wall, provide a suitable seal to close openings. Refer to drawings for details.

I. Provide junction or pull boxes in conduit lines which have greater than 360-degrees in total bends.

J. Install pull and/or junction boxes in conduit lines wherever necessary to avoid excessive length of runs or number of bends in run. No run shall exceed 100 feet without a pull box.

K. Pull and junction boxes shall be accessible and sized in accordance with provisions of Article No. 370-18 of latest edition of National Electrical Code.

L. Pull and junction boxes shall be installed so that cover shall be accessible at all times.

END OF SECTION 26 05 33

SECTION 26 05 35 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install wall switches, plug receptacles, etc. as specified hereafter and shown on the drawings. Devices offered as a substitute to those specified will be carefully checked to see that quality such as grounding continuity, retention force for insertion devices, are equal to those specified.

1.2 REFERENCES

A. General provisions of the Contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The plug receptacles shall have a minimum rating of 20 amperes for the voltage service applied.

B. Wall switches shall be 20-ampere, minimum capacity and single pole, 3-way or 4-way as required. Other variations of the devices shall be as called for on the drawings. Where pilot lights are required, they shall be separately ganged.

C. Special colors may be required by the Architect and request for color variation must be made well in advance of product procurement. For the basis of the specification, it shall be assumed that the switch device handles and plug receptacle bodies are white, grey, or ivory.

D. Coverplates: Stainless steel coverplates shall be used.

E. The manufacturer shall be Hubbell, General Electric, Bryant, P & S, Leviton, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of devices shall be in accord with the manufacturer's recommendations. Grounding devices such as jumper straps between the

device grounding pole and the junction box, or the connection of a grounding conductor will be required at each plug receptacle. Where metal conduit serves the outlet box, a device using a "UL" approved grounding arrangement making use of the contact between the yoke and the device box is approved for use.

END OF SECTION 26 05 35

SECTION 26 05 39 – FLOOR BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install flush floor boxes where indicated on drawings and as set forth hereinafter.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flush floor boxes shall be similar and equal to Wiremold/Walker Company catalog No. RFB4-SS, 4-compartment combination box. Each floor box shall contain two duplex plug receptacle brackets (RFB-RB-SS) and two quad RJ45 brackets (RFB-4TKO-SS). Activation covers for floor boxes shall be Walker catalog No. S36CCTCXX complete with wire management seals. Cover shall be suitable for use in carpet, tile, terrazzo, and wood-covered concrete floors. Activation covers shall be U.L. evaluated and approved to meet applicable U.S. and Canadian safety standards for scrub water exclusion. Activation covers shall be die cast aluminum with powder coat paint finish. Color shall be aluminum, brass, or black as selected by architect. Provide floor insert in covered doors to match floor finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In each flush floor box, provide two duplex plug receptacles in each of the compartments which are indicated to serve the electrical needs. Where greater capacities are required, they shall be as noted on drawings.

B. Verify all locations of floor boxes with architect prior to installation. Do not scale floor box location from electrical drawings.

C. Installation of flush floor boxes shall be in strict accordance with manufacturer's written recommendations.

END OF SECTION 26 05 39

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 91 13 – General Commissioning Requirements

C. Section 22 08 00 – Commissioning of Plumbing Systems

D. Section 23 08 00 – Commissioning of HVAC

1.2 SCOPE

A. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning verifies that systems are operating in a manner consistent with the Contract Documents.

B. Refer to Part 3 of this section for a detailed list of equipment included in each commissioning activity.

1.3 RESPONSIBILITIES

A. The Contractor shall be responsible for adhering to applicable code required procedures, standards and industry practices to ensure personal safety, the safety of others, and facility safety with regard to electrical equipment operation and testing. If there are procedures in the checklists or the functional performance tests which conflict with safety, the Contractor shall not proceed and shall notify the CxA immediately.

PART 2 - PRODUCTS

2.1 MEANS OF ACCESS

A. The Contractor shall provide means for the CxA to access, observe and visually confirm proper operation of all equipment and systems. These means shall be in compliance with all OSHA and job-site safety regulations.

2.2 TEST EQUIPMENT

A. The Contractor shall provide the necessary equipment to fully test the commissioned systems as defined in the Contract Documents and as

defined in the functional performance test procedures to be provided by the CxA.

B. The test equipment shall meet the following minimum requirements.
   1. All test equipment shall be in good mechanical and electrical condition.
   2. Field test metering used to check power system meter calibration will be more accurate than the instrument being tested.
   3. Accuracy of metering in test equipment shall be appropriate for the test being performed.
   4. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

C. Calibration
   1. Calibration of all test equipment shall be current.
   2. Calibration accuracy shall be traceable to National Institute of Standards and Technology (NIST).
   3. Test equipment shall be calibrated in accordance with the following schedule.
      a. Field instruments
         1) Analog – At least every 6 months
         2) Digital – At least every 12 months
      b. Leased Specialty Equipment – At least every 12 months
   4. Dated calibration labels shall be visible on all test equipment.
   5. Calibration records shall be provided for all test equipment used in the project.

PART 3 - EXECUTION

3.1 START-UP PLAN

A. The Contractor shall perform start-up testing for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing may proceed without delays.

B. The Contractor shall prepare a start-up plan for each piece of equipment. This plan shall be submitted to the CxA for review and comment. The start-up plan shall consist, at a minimum of the following:
   1. The manufacturer's standard start-up and check out procedures copied from the installation manuals.
   2. Checklists and procedures with specific spaces for recording and documenting the inspection of each procedure and a summary block for deficiencies and explanations.

C. Two (2) weeks prior to expected start-up for a piece of equipment, the Contractor shall notify the Owner and the CxA in writing. The execution of the start-up plan shall be directed and performed by the Contractor. The CxA and/or the Owner may be present for the start-up of the first unit of each type of equipment.

D. The Contractor shall submit the completed equipment checklists to the CxA for review. The Contractor shall note all non-compliance items on these checklists. The Contractor shall notify the CxA when outstanding items have been corrected.

E. The Contractor shall complete the start-up plan and resolve or correct all issues resolved before functional testing may begin.

3.2 EQUIPMENT PRE-FUNCTIONAL CHECKLISTS

A. Equipment pre-functional checklists, provided by the CxA, shall be completed by the Contractor on the following systems:
1. Automatic Transfer Switch
2. Emergency Generator
3. Panelboards
4. Switchboard
5. Transformers
6. Power Monitoring System
7. Interior Lighting Controls
8. Emergency Lighting

3.3 FUNCTIONAL PERFORMANCE TESTS

A. The Contractor shall provide all documentation as requested to the CxA for development of functional performance testing procedures. This documentation shall include, at a minimum, manufacturer installation, start-up, operation and maintenance procedures. The CxA may request further documentation as necessary for the development of functional performance tests.

B. Functional Performance Tests, provided by the CxA, shall be performed on the following system (sampling rates are indicated in parenthesis, assume these to be 100% unless noted otherwise):
1. (1) Automatic Transfer Switch
2. (1) Emergency Generator
3. (12) Panelboards
4. (1) Switchboard
5. (6) Transformers
6. (1) Power Monitoring System (30%)
7. Interior Lighting Controls (30%)
8. Emergency Lighting (30%)

C. The sampling rates shown above are to be considered a minimum. The contractor is expected to perform functional testing on 100% of commissioned equipment but no less than shown above.

D. The Contractor shall review the functional performance test procedures developed by the CxA.
1. The Contractor shall respond in writing to the CxA regarding the acceptability of the proposed test procedures.

2. The Contractor shall note any necessary modifications to the procedures due to the actual equipment/systems or safety concerns and shall submit these to the CxA for consideration.

E. The Contractor shall place equipment and systems into operation and continue the operation as required during each working day of the testing activities.

F. The Contractor shall accomplish the functional performance testing of equipment based on procedures developed by the CxA and as reviewed by the Contractor.
   1. The Contractor shall provide skilled technicians to operate the systems during functional performance testing.
   2. The Contractor shall correct any deficiencies as identified during testing and retest equipment as required.

G. Functional performance testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of the system at the discretion of the CxA and the Contractor.

3.4 DEFERRED FUNCTIONAL PERFORMANCE TESTING

A. The Contractor shall perform any deferred testing as required to properly demonstrate successful operation to the Owner.
   1. Some test conditions may not be able to be simulated and thus require these actual conditions to be present to implement the test.
   2. A mutually convenient time to the Owner, CxA and Contractor will be scheduled when these test conditions will be present to conduct this deferred testing.

B. The Contractor shall perform these tests as indicated in the functional performance test procedures.

C. The Contractor shall correct any deficiencies or failures identified in the process of performing these tests.

END OF SECTION 26 08 00

SECTION 26 12 19 - THREE PHASE PADMOUNTED TRANSFORMER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install outdoor padmounted liquid-filled transformer of capacity as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Transformer shall be 3-phase, oil-immersed, self-cooled, 60 hertz, and 65 degrees C rise. Primary voltage shall be 13,200-volts, delta; secondary voltage shall be 480Y/277 volts. Provide four 2-2-1/2% full capacity primary taps, two above and two below rated voltage. Capacity as shown on the drawings.

B. Construct unit in accordance with ANSI Standard No. C57.12.26.

C. Provide full height, air filled incoming and outgoing terminal compartments with hinged doors, separated by a steel barrier. Construction of unit shall be dead-front. Equip primary section with six 200-ampere bushing wells in accordance with ANSI Standard C119.1. Low voltage bushings shall be timed, spade-type with 9/16” hole spaces on 1-3/4” centers, six holes per blade. Provisions for grounding shall be provided in both high and low voltage sections.

D. Provide three dead-front type M.O.V.E. surge arrestors, rated 10 KV, 12.7 KV MCOV, IEEE 386 and C62.11.

E. Unit shall have BIL of 95-KV and a 15-KV insulation class.

F. All windings in transformer shall be copper.

G. Unit shall have provisions for lifting, jacking, rolling, and padlocking.

H. Coolant in transformer shall be a synthetic ester fluid, less flammable dielectric liquid (Cooper “Envirotemp”). Fluid shall conform to IEC 61099, “Specifications for Unused Synthetic Organic Esters for Electrical Purposes.”

The synthetic fluid shall meet IEC, IEEE, and IS Standards. It shall be classified as a less flammable fluid, with more than twice the flash and firepoint as mineral oil. Fluid shall be readily biodegradable per OECD 301. Fluid shall be non-hazardous in water and soil.

The fluid shall be formulated with greater than 98.5% vegetable oil by weight. Fluid shall have a closed cup flashpoint of between 310 and 320-degrees C. Boiling point must exceed 360-degrees C.

I. Unit shall be similar to Cooper padmounted transformer. Alternate manufacturers are ABB, Square D, Siemens, or equal.

J. Transformer shall be U.L. classified for installation per Article 450-23 of the National Electrical Code.

K. Transformer shall be factory mutual rated.

L. The transformer secondary spades shall include cable support.

M. Transformer shall be equipped with oil-immersed current limiting fuse, sized by transformer manufacturer for specific transformer. Provide one complete set of spare fuses for owner. Provide on/off internal load break switch with handle located in primary compartment. The primary switching scheme provided with the transformer shall be 4-position, on/off, V-blade, gang operated load break switch. Switch shall be break before make. Switch shall meet IEEE C37.7.1 2001, 12.5 KA fault withstand.

N. Equip transformer with pressure relief device, minimum rated of 35 SCFM at 15 psi. Transformer tank shall be able to withstand internal pressure of 15 psi without rupture.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Place new transformer on an elevated concrete pad, minimum 8” above adjacent surface, and anchor in position. Provide a well opening in concrete pad to allow entry of conduit and grounding conductors. Install ground rods called for under grounding section of specifications with a grounding conductor entering and looped between both primary and secondary compartments of transformer. A ground connection shall be made to secondary neutral and to transformer housing in two different locations. Conform to manufacturer’s recommendations. Equip transformer with brass tumbler type padlock.

END OF SECTION 26 12 19

SECTION 26 22 13 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install dry-type transformers where called for on the drawings to provide 208Y/120-volts from the basic building 480-volt, 3-phase service.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide totally enclosed, non-ventilated transformers with IP55 (dust-tight) rating where noted on drawings.

B. Otherwise, new dry-type transformers shall be similar and equal to General Electric Company type "ML" or "QL" of particular capacity required. All transformers shall have aluminum windings and have standard NEMA taps so as to allow adjustment of output voltage. All transformer taps shall be rated 2-1/2 percent of rated input voltage. All transformers shall be rated for 115 degrees C. temperature rise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting of the transformers shall be floor mounted except where indicated to be mounted overhead. Overhead mounted transformers shall be attached to the building structural system for use of trapeze hangers and bolted connections through the structural members.

B. Provide grounding of new dry-type transformers. See details on drawings for additional information.

END OF SECTION 26 22 13

SECTION 26 24 13 - SWITCHBOARD (480-VOLTS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install a free-standing main switchboard as illustrated on the drawings and called for hereinafter.

1.2 RELATED WORK

A. General Provisions of the Contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The switchboard shall be dead-front, free-standing, having cable and conduit, incoming feed, copper bus, grounded neutral.

B. Provide ground fault protection on the main breaker.

C. The equipment shall be UL approved for service entrance equipment and labeled accordingly.

D. Provide conduit area for entry from the bottom and departure from the bottom.

E. The switchboard shall contain integrated equipment with short circuit ratings that will certify that all equipment is capable of withstanding a fault equal to that of the least overcurrent protective device contained therein. Test ratings shall be established by actual test by the manufacturer on similar equipment construction as the subject switchboard. The test data shall be available and shall be furnished to the engineer at the time of submittal of drawings for approval.

F. Laminated plastic nameplates shall be provided for each circuit breaker identifying the loads being served by the particular circuit breaker.

G. Equip switchboard with built-in digital meter. Meter shall monitor the following: Voltage (L-L, L-N), current, KW, KWH, power factor, voltage THD per phase, and current THD per phase. Meter shall be similar and equal to Square D Power Logic Meter with optimal enhanced package, with communications ports to allow central energy management system monitoring by Modbus or Bacnet protocol.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to manufacturer's recommendations. Submit shop drawings illustrating the equipment. Shop drawings shall be to scale and dimensioned, showing the outline of the equipment. Switchboard shall contain both a neutral and a ground bus.

B. At completion of job, contractor shall have test performed of ground fault protection system. Submit test results to Architect.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install panelboards with circuit breaker equipment as indicated on drawings and specified hereinafter.

1.2 RELATED WORK

A. General Provisions of the Contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

1.3 SHOP DRAWINGS

A. Shop drawings shall be submitted for approval. Shop drawings shall be specific indicating busing, breaker dimensions, gutter dimension, number size, trip, and interrupting capacity of all circuits. Refer to Specification Section 013300.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Equipment shall be product of Square D Company, G.E., Siemens, or Eaton. Branch circuit panelboards shall be of the circuit breaker, dead-front safety type Square D types "NQOD" or “NF” Series with contents, as indicated on panel scheduled, shall bear approved device label of UL, and shall meet all applicable requirements of National Electrical Manufacturers Association. Use bolt-on circuit breakers. Panelboard busing shall be copper.

B. Number of branch circuits, their rating, number of poles arrangements, etc., are indicated on drawings.

C. Panelboards shall have lugs (both main lugs and branch circuit lugs) suitable and UL approved for both aluminum and copper conductors. Such panelboards shall have their breakers labeled and approved by UL.

D. Provide neutral bars for all 4-wire system feeders. Isolate such neutral bars from the panel box.

E. Panels shall have a separate "ground bar" installed with lugs or connectors on bar. Such bar shall be grounded to panel box.

F. Bus bars shall be of sequence-phase type arranged for 120/208-volts, 3-phase, 4-wire mains or 480/277-volt, 3-phase, 4-wire mains. All circuits shown as

common neutral shall be installed in accordance with National Electrical Code. All bus bars shall be copper (including ground bus).

G. Multiple breakers shall have common trip. Trip indication shall be as indicated by breaker handle moving to a position other than ON or OFF. Equip doors on panels with chrome-plated lock and a catch with two keys supplied for each lock concealed hinges and attachment means. Panelboards shall be flush or surface mounted as required.

H. Furnish six handle "lock-on" devices for each panel for installation on circuits as directed by Owner to prevent unauthorized personnel from turning off circuits to controls, unit heaters, clocks, night lights, etc. Any spare lock-ons remaining shall be turned over to Owner for his use.

I. Provide typed or printed directory cards under plastic on doors. Submit detailed drawings for approval showing size of cabinets, trim, detail for busing, locks, method of numbering, voltage, phase, etc., and obtain approval from Architect before manufacture is commenced.

J. Distribution or power panels shall be similar and equal to Square D I-line type, or Eaton Type CDP circuit breaker distribution panelboard. This shall include all panels rated greater than 225-amperes. The main distribution panel shall contain all solid state circuit breakers, and have dual level ground fault protection.

K. Circuit breakers shall be fully rated and temperature rated for a 40 degrees C. ambient. All panelboards shall have lugs (both main lugs and branch circuit lugs) suitable and UL approved for aluminum and copper conductors. Such panelboards shall have their breakers labeled and approved by UL.

L. Breakers shall be of thermal magnetic type, sized and numbered as indicated on schedule on drawings, and shall be quick-make, with trip indication shown by a handle position other than ON or OFF with trip on all multipole breakers.

M. Minimum short circuit interrupting capacity shall be as indicated on panel schedule.

N. Panelboard fronts shall have concealed hinges and attachment bolts, be complete with door cylinder lock and catch, all keyed alike. Fronts shall have adjusting indicating trim clamps and Bakelite nameplates engraved to indicate device, panel, or motor being served. Spare breakers and spaces only shall have nameplates with no engraving. Secure all nameplates to panelboard trim with two round head sheet metal screws.

O. Panelboards shall be UL approved. Panelboard main sizes, branch circuit rating, and mounting shall be as indicated on plans. Shop drawings shall be submitted for approval. Shop drawings shall be specific showing busing, breaker dimensions, gutter dimensions, spare space dimensions, number, size, trip, and interrupting capacity on all circuits. Standard factory work sheets will not be acceptable as shop drawings.

P. Circuit breakers shall not be restricted to any mounting location due to their physical size. All branch circuit breakers rated 15 through 100 amperes shall be capable of mounting in any and all interior positions without space penalty, except it is allowable to limit any connection point to 100-amperes. All branch circuit breaker connections shall be copper to copper, with all terminations being fully rated at 100-amperes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Secure surface mounted panelboards to wall using 1/4" toggle bolts, bolted to masonry wall. Where hollow block walls do not occur, suitable expansion shields and anchor bolts shall be utilized. Unless directed otherwise, panelboards shall be mounted to have the top 6 feet clear above finished floor.

B. The directories within each panelboard shall be properly filled out, so as to have a comprehensive understanding of the loads to which each circuit breaker is connected. They shall be filled out by use of a typewriter. This shall include room number served.

C. Panelboards shall be painted to match adjacent walls and labeled inside with a suitable engraved, laminated plastic plate to identify the panelboard designation and its voltage.

D. Balance all circuits in a panel to achieve not more than 10 percent unbalanced neutral current in panel feeder. Panel circuit numbering shall be revised as necessary and arranged to facilitate above.

END OF SECTION 26 24 16

SECTION 26 28 16 - SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install fuse safety switches and/or disconnect switches as called for on the drawings and as may be otherwise required by the Codes.

1.2 REFERENCES

A. General Provisions of the contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Safety switches shall be heavy-duty, horsepower rated, quick-make, quick-break with arc shields with enclosed construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install where called for on the drawings and/or as required by the National Electrical Code.

B. Where disconnect or safety switches are called for away from walls, suitable support shall be provided to allow the switch to be in a position of approximately 4-1/2 feet above floor. Where necessary, provide a steel frame attached to the floor or overhead structural system or both. Switches may be mounted on equipment where specific approval is realized from the supplier of the equipment, so as not to interfere with normal and ready maintenance of the equipment.

END OF SECTION 26 28 16

SECTION 26 29 13 - MANUAL MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install manual motor starters for 120-volt equipment as shown on drawings and called for hereinafter.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manual motor starters shall be equipped with melting alloy type thermal overload relay. Manual motor starters shall be provided with pilot lights. Unit shall be similar and equal to Square D Company 2510 Series, catalog No. FF-1P.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Manual motor starters shall be installed at HVAC equipment in accordance with NEC requirements for disconnecting means. Install in accordance with manufacturer's recommendations.

END OF SECTION 26 29 13

SECTION 26 32 13 - NATURAL GAS GENERATOR SET

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install an automatic power generating system and associated wiring to furnish emergency power to the emergency lighting, and related essential systems as specified herein and illustrated on the drawings. Generator shall be for outdoor use. Unit shall be capable of restoring power to critical systems within 10 seconds of failure of commercial power.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The gas driven standby electric system shall be provided having standby rating as noted on drawings, 277/480-volts. The systems shall be a package of new and current equipment consisting of:
   1. A gas engine driven electric generating set to standby power.
   2. An engine start-stop control system mounted on the generating set.
   3. An automatic load transfer control to provide automatic starting and stopping of the engine and switching of the load.
   4. A remote annunciator.
   5. A weather-protective Level 2 sound attenuated housing.

B. The standby electric power system furnished completely by the manufacturer, shall be warranted for a period of five years from the date of installation.

C. The engine shall be natural gas fueled, water cooled with mounted radiator, fan, and water pump. Engine speed shall be governed to maintain alternator frequency within 5 percent from no-load to full-load alternate output. The engines shall have a 12-volt battery charging DC alternator with a transistorized voltage regulator. Remote, 2-wire, starting shall be by a 12-volt electric starter. The engine shall have air cleaner, fuel and oil filters with replaceable elements, water jacket heater, and a fuel transfer pump. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. Exhaust valve seat inserts shall be provided. Intake and exhaust valves shall be heat resisting alloy steel with free rotating exhaust valve. The engines operating speed shall be 1800-rpm. Engine shall be 4-stroke type.

D. Engine Instruments: The engine instrument panel shall contain an oil pressure gauge, coolant temperature gauge, and battery charge rate ammeter.

E. Engine Controls: The generating set shall contain a complete engine start-stop control which starts engine on closing contact and stops engine on opening contact. A cranking limiter shall be provided to open the starting circuit approximately 45 to 90 seconds if the engine is not started within that time. The engine controls shall also include a 3-position selector switch with the following positions: RUN-STOP-REMOTE,

high engine temperature, low oil pressure, and overspeed shutdown with individual signal lights and common alarm shall also be provided.

F. Brushless Alternator: The alternator shall be a 4-pole revolving field design with temperature compensated solid state voltage regulator and brushless rotating rectifier exciter system. No brushes shall be allowed. The stator shall be directly connected to the engine flywheel housing, and the motor shall be driven through a semi-flexible driving flange to insure permanent alignment. The insulation system shall be Class F as defined by NEMA MG1-1.65. The three-phase, broad range alternator shall be 12-lead reconnectible. The generator set shall have a mounted circuit breaker sized as indicated on plans. Provide lugs ahead of main for fire pump operation.

G. Unit Performance: Unit shall have isochronous governor for +/-0.5 percent frequency regulation. Voltage regulation shall be within plus or minus 2 percent of rated voltage, from no load to full rated load. The instantaneous voltage dip shall be less than 18 percent of rated voltage when full, 3-phase, load and rated power factor is applied to the alternator. Recovery to stable operation shall occur with 2 seconds. Stable or steady operation is defined as operation with terminal voltage remaining constant within plus or minus 1 percent of rated voltage. A rheostat shall provide a minimum of plus or minus 5 percent voltage adjustment from rated value. Temperature rise shall be within NEMA MG1-22.40 definition.

H. Alternator Instrument Panel: The alternator instrument panel shall be wired, tested, and shock mounted on the generating set by the manufacturer. It shall contain panel lighting; manual reset circuit breaker; frequency meter; running time meter; voltage adjusting rheostat; AC voltmeter; AC ammeter; and voltmeter-ammeter phase selector with OFF position.

I. Generating Set Mounting: The electric generating set shall be equipped with vibration isolators and mounted on a welded steel base which shall provide suitable mounting to any level surface.

J. Accessories: All accessories needed for the proper operation of the generating sets shall be furnished. These shall include residential silencing muffler, weather protective housings rated for Level Two sound attenuation, flexible exhaust connection, starting batteries, battery cables, battery racks, flexible gas lines, and detailed operation and maintenance manuals with parts list. Provide rain caps for exhaust lines. Install one battery charger at genset. Battery charger shall be 10-ampere full float SCR type. It is acceptable for battery charger to be included as an accessory of the automatic transfer switches. Generator housing shall have custom color to be selected by Architect.

K. Annunciator: Furnish and install a remote annunciator in building where directed. Annunciator panel shall be equipped with both audible and visible signal devices to monitor and warn of malfunction or alarm conditions. Conditions monitored shall include those listed for Level One installation in NFPA 110.

L. Engine shall be equipped with water jacket manifold heater to insure starting in low temperatures.

M. Generators shall be Onan Company, Caterpillar Company, Kohler Company, or Generac Company.

N. Automatic Load Transfer Control:

1. Use Onan Type OT III automatic transfer switches or equal by Automatic Switch Company. Switches shall be 3-pole, NEMA 1 enclosure. The load transfer shall be rated for continuous duty and for all classes of load. The control components shall be minimum rating as indicated on the drawings. The control components shall be compatible with the electrical requirements of the standby set and provide the following functions:

   Upon power line outage, automatically start the generating set and when the set comes up to speed and voltage, disconnect the load circuits from the power line and transfer them to the standby sets output.

   Upon power line return, transfer the load back to the line and stop the standby set.

   Refer to the drawings for transfer switch ampere ratings, quantities, and arrangements.

2. Transfer switch accessories shall include: Plant exerciser under load conditions; time delay start, adjustable; time delay transfer and retransfer adjustable; time delay on stopping plant; simulated power failure test switch. Switch shall have programmed transition feature, set at one second.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount generating set with spring vibration isolators directly to new concrete pad. Bolt directly to pad.

B. Provide factory authorized technicians for initial start-up of system.

C. Provide on-site testing and start-up per NFPA 110 – Level One installation.

END OF SECTION 26 32 13

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans.

B. The ATS shall transfer the load in delayed transition (break-before-make) mode. Transfer is accomplished with a user-defined interruption period in both directions adjustable from 1 second to 5 minutes in at least 15 increments.

1.2 CODES AND STANDARDS

The automatic delayed transition transfer switches and accessories shall conform to the requirements of:

A. UL 1008 - Standard for Transfer Switch Equipment

B. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment

C. NFPA 70 - National Electrical Code

D. NFPA 110 - Emergency and Standby Power Systems

E. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

F. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches

G. UL 508 Industrial Control Equipment

1.3 ACCEPTABLE MANUFACTURERS

A. Automatic delayed transition transfer switches shall be similar and equal to ASCO Series 7000, or equal by Kohler, Generac, and Onan.

PART 2 - PRODUCTS

2.1 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a solenoid mechanism, momentarily energized. The transfer switch unit shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time. Main operators which include overcurrent disconnect devices OR do not include electrical and mechanical interlocks will not be accepted.

B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

H. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 MICROPROCESSOR CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. EN 55011:1991 Emission standard - Group 1, Class A
2. EN 50082-2:1995 Generic immunity standard, from which:

   EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity

ENV 50140:1993 Radiated Electro-Magnetic field immunity

EN 61000-4-4:1995 Electrical fast transient (EFT) immunity

EN 61000-4-5:1995 Surge transient immunity

EN 61000-4-6:1996 Conducted Radio-Frequency field immunity

3. IEEE472 (ANSI C37.90A) Ring Wave Test.

2.3 ENCLOSURE

A. The ATS shall be furnished in a NEMA 1 enclosure unless otherwise shown on the plans.

B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

PART 3 - OPERATION

3.1 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration (Open transition, Closed transition or Delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 VOLTAGE, FREQUENCY, AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E,3ϕ	70 to 98%	85 to 100%
Overvoltage	N&E,3ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

E. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency and phase rotation.

3.3 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. An adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay all retransfer signals during initial loading of engine generator set.

D. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

E. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

F. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

G. The controller shall also include the following built-in time delays for Delayed Transition & Bypass-Isolation operation:

1. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

H. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

I. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port. The time delay value displayed on the LCD or remote device shall be the remaining time until the next event occurs.

3.4 ADDITIONAL FEATURES

A. A three position momentary-type test switch shall be provided for the *test / automatic / reset* modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal. Switches which require utilizing the keypad and display function or have no manual time delay bypass means are not acceptable.

B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

H. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

I. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routine.
3. Set the start time, .
   - time of day
   - day of week
   - week of month (1st, 2nd, 3rd, 4th, alternate or every)
4. Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

J. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

K. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

L. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

M. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging

   a. Date and time and reason for transfer normal to emergency.
   b. Date and time and reason for transfer emergency to normal.
   c. Date and time and reason for engine start.

d. Date and time engine stopped.
e. Date and time emergency source available.
f. Date and time emergency source not available.

2. Statistical Data

a. Total number of transfers.
b. Total number of transfers due to source failure.
c. Total number of days controller is energized.
d. Total number of hours both normal and emergency sources are available.

N. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72.

PART 4 - ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.

B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATS which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

4.2 TESTS AND CERTIFICATION

A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

4.3 SERVICE REPRESENTATION

A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service

center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

4.4 DATA MONITORS

A. The Data Monitors shall be flush mounted and be equipped with an optional continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:
1. Current, per phase RMS and neutral (if applicable)
2. Current Unbalance %
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage Unbalance %
5. Real power, per phase and 3-phase total
6. Apparent power, per phase and 3-phase total
7. Reactive power, per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated Energy, (MWH, MVAH, and MVARH)

A. Displaying each of the Data Monitor quantities shall be accomplished through the use of menu scroll buttons.

B. For ease in operator viewing, the display shall remain on continuously, with no detrimental effect on the life of the Data Monitor.

C. Setup for system requirements shall be allowed from the front of the Data Monitor. Setup provisions shall include:
1. CT rating (xxxxx:5)
2. PT rating (xxxxxxx:120) (if applicable; 24000V maximum)
3. System type (single; three phase; 3 and 4 wire)
4. Communication parameters

D. Reset of the following electrical parameters shall also be allowed from the front of the Data Monitor:
1. Real energy (MWH), apparent energy (MVAH) and reactive energy (MVARH).

F. All reset and setup functions shall have a means for protection against unauthorized/accidental changes.

END OF SECTION 26 36 23

SECTION 26 43 13 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section describes the materials and installation requirements for Surge Protection Devices (SPD's) formally known as Transient Voltage Surge Suppressors (TVSS) as shown on the drawings and herein specified at main and branch circuit distribution panels.

1.2 REFERENCES:

A. ANSI/IEEE C62.41-1991 and C62.45-1992.
B. National Electrical Manufacturers Association, NEMA LS-1, Revision 2007.
C. National Fire Protection Association, NFPA 70.
D. Underwriters' Laboratories UL 1449 and 1283.

1.3 MANUFACTURER'S QUALIFICATIONS:

A. Manufacturers shall be ISO9000 certified.

B. Manufacturers shall have been engaged in the design and manufacturing of surge protection devices for at least ten (10) years.

C. The following manufacturers will be approved, provided they meet all specifications:

1. ERICO Products Inc. 34600 Solon Road, Solon OH 44139
2. Equal products by Leviton, Innovations Technology, APT, and Wiremold Sentrex.

1.4 WARRANTY:

A. The manufacturer shall provide a minimum of a five (5) year warranty from the date of shipment against failure when installed in compliance with national and local electrical codes; and per the manufacturer's installation, operation and maintenance manuals. Products with warranties that exclude temporary over voltage conditions, abnormally high number of surges, direct or indirect lighting strikes shall not be used.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS:

A. The Surge Protection Device shall be listed to UL 1449 Edition 3 as a SPD Type 1 or SPD Type 2 Product.

B. The UL 1449 Edition 3 Nominal Discharge Current (In) for the Surge Protection Device shall be 20 kA. A Surge Protection Device with a UL 1449 Edition 3 Nominal Discharge Current listing of 3 kA, 5 kA, or 10 kA will not be accepted.

C. MCOV shall be greater than 115% of the nominal operating voltage.

D. The Surge Protection Device shall have a stand-off voltage rating twice the nominal voltage. The Surge Protection Device shall be able to withstand Temporary Over Voltage Conditions twice the nominal voltage for an indefinite period of time, without damage, removing components from the circuit, or interrupting panel.

E. The Surge Protection Device shall protect all modes via L-N, L-G and N-G modes of protection. For Delta power systems L-L and L-G protection modes shall be provided, with the ability to configure L-G to L-L for ungrounded systems.

F. Independent certification shall be provided proving that the Surge Protection Device meets the required 8/20µs per phase single shot surge rating, without failure of any fusing, disconnects or surge module. Bypassing of any fusing/disconnects for purpose of this test is not acceptable.

G. Each mode of the Surge Protection Device shall be rated to exceed the life cycle testing of ANSI/IEEE C62.45 by withstand of at least 200 operations at 10kA 8/20µs and at least 100 operation at 20 kA without failure.

H. The Surge Protection Device shall have a Short Circuit Current Rating (SCCR) of 200 kAIC, per UL 1449 Edition 3.

I. The Surge Protection Device shall be capable of withstanding multiple temporary over-voltage per UL 1449 Ed 2 Section 36 “Overvoltage Test”, & 37 “Abnormal Overvoltage Tests” without failure or need to reset or replace modules/fuses.

J. Each MOV shall be protected with individual thermal disconnect devices bonded directly to the MOV substrate for rapid and automatic disconnection of any MOV exhibiting excessive temperature. The following are not acceptable:

1. Surge Protection Devices without thermal fuses/disconnects.
2. Surge Protection Devices with shared thermal devices that disconnect more than one MOV.

K. For safety, the Surge Protection Device shall have a maximum continuous operating voltage (MCOV) of at least:

Power System	MCOV (L-N)
Single phase (2W+G) 220-240V	310V
Three phase (4W+G) 120/208 WYE	170V
Three phase (4W+G) 277/480 WYE	310V

L. Enclosure shall:

1. Feature all metal NEMA 4 enclosure suitable for outdoor usage.
2. The Surge Protection Device depth shall be less than 3.5” to allow mounting within wall cavity with optional flush mount kit.
3. The Surge Protection Device width shall be less than 5” to enable installation between adjacent electrical enclosures.

2.2 MAIN SERVICE PANELS

Surge Protection Devices shall be installed at all AC service entrances of each building.

A. The Surge Protection Device shall incorporate 200kA 8/20µs MOV protection per phase.

B. The TVSS shall have the following status indications:

1. Each individual mode of protection shall be separately monitored and displayed via a mechanical flag status indication for each mode.
2. A LED status indication per phase.
3. An overall status LED
4. Form-C alarm contacts for remote alarming of faults
5. Audible Alarm.
6. A five (5) digit surge counter that cannot be reset.

C. The Surge Protection Device shall have a built-in disconnect that allows fusing and surge components to be removed without interrupting power, or disconnecting hard wire connections.

D. he following Voltage Protection Ratings (VPR) shall not be exceeded by the Surge Protection Device.

	Voltage Protection Rating	
Impulse standard (no AC applied)	120/240 V 120/208 V	277/480 V
ANSI/IEEE C62.41 Cat B3 3kA	600V	1000V
ANSI/UL 1449 Edition 3 20 kA Nominal Discharge Current Testing	1200V	1800V

E. At least -40dB @100 kHz EMI/RFI shall be provided L-N (L-L for Delta units). To avoid unsafe ground leakage current, no filtering shall connect to ground.

F. ERICO, CRITEC TDX200 Modular Series or similar meeting these specifications.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install Surge Protection Devices in full accordance with manufacturer's written instructions and comply with all applicable codes.

B. Surge Protection Devices with a UL 1449 Edition 3, Listing as a SPD Type 2 shall have a 30-amp circuit breaker or other size as recommended by the manufacturer's installation manuals. This independent circuit breaker will serve as a means of a disconnect for servicing the Surge Protection Device with the protected panel remaining energized.

C. Surge Protection Devices with a UL 1449 Edition 3 Listing as a SPD Type 1, and an integrated disconnect can be connected directly to the buss without a designated circuit breaker.

D. The Surge Protection Device shall be installed with the shortest possible leads, or conductor length, minimum No. 8 AWG.

END OF SECTION 26 43 13

SECTION 26 51 00 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install the lighting fixtures as called for on the drawings and specified hereinafter. Equipment shall be complete including lamps and accessories with the mounting arrangement suitable for the mounting condition encountered.

1.2 REFERENCES

A. General Provisions of the Contract, General and Supplementary Conditions, and Division 1 Specification Sections, General Requirements, apply to this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The lighting fixtures shall be as listed in the lighting fixture schedule shown on the drawings.

B. Fluorescent lamps shall be rapid start, 32-watts with initial lumen output of not less than 2,900. They shall be rated 3500 degrees K., and with not less than 82 CRI. Refer to drawings for additional information.

C. Fluorescent ballasts shall meet the standards of the Certified Ballast Manufacturers and be high frequency electronic type. Refer to drawings for additional information.

D. Compact fluorescent lamps shall be 3500° K, to match fluorescent lamps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each lighting fixture shall be secured to the ceiling or structural framing system. Attachment to ceiling board, metal lath, or gypsum panels is not satisfactory. Suitable framing must be provided to engage the actual structural elements of the building or ceiling.

B. Fixtures in lay-in ceiling applications shall be clipped to the ceiling framing as required by the National Electrical Code. Provide a sample installation for approval before fixtures are installed.

C. Except where prefabricated wiring is called for, fluorescent lighting fixtures shall be wired by the installation of a junction box at the fixture. Conduit connections directly to the fixture housing are not acceptable.

D. All noisy ballasts creating a hum shall be replaced as directed.

E. Verify the type of ceiling construction prior to shipping fixtures to the job.

END OF SECTION 26 51 00

SECTION 26 53 00 - EXIT SIGNS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install exit signs where illustrated on the drawings. Mounting shall be as set forth on the drawings and specified hereinafter. All exit signs shall have red letters and have light emitting panels. They shall conform to the requirements of the National Fire Protection Association Codes.

1.2 SUBMITTALS

A. Submit the manufacturer's complete specifications and installation instructions for equipment furnished under this section.

B. Submittals shall conform to Section 013300, Submittals-Procedures.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Exit signs shall be die cast aluminum, similar to Lightalarms GXE-WRW-1G. Lamps shall be light emitting diodes. Each exit sign shall have built-in nickel cadmium standby battery and diagnostic/self-test feature.

B. The unit mounted on a lay-in type ceiling shall be supported by use of a Caddy Company acoustical "Tee Bar" box hanger, catalog No. 512 or similar product.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The unit shall be arranged for the mounting called for on the drawings, either single face or double face or either ceiling mounting or wall mounting. Directional arrows shall be provided as indicated. Where ceilings above 9 feet are involved, the ceiling mounted units are to be pendant mounted to where the bottom of the sign is approximately 8'6" above floor.

B. Conform to the manufacturer's recommendations.

END OF SECTION 26 53 00

SECTION 26 54 00 – TWIN HEAD EMERGENCY LIGHTING UNIT

PART I - GENERAL

1.1 DESCRIPTION

A. Furnish and install twin-head emergency lighting units where shown. Unit shall be wall mounted as indicated on drawings. This unit shall have built-in battery, self chargeable and twin adjustable incandescent lamps. It shall be used to furnish emergency lighting in case of interruption of normal power. It shall automatically switch the lights on when normal power is interrupted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The wall-mounted unit shall be rated 120-volts, 540-watt, containing two 20-watt, 12-volt halogen lamps. Unit shall contain nickel-cadmium battery unit with self charger and automatic switching devices, and integral time delay. Unit shall be similar and equal to Lithonia Company No. ELM1254-H1212-N. It shall be equipped with a transfer circuit which will prevent deep discharging of batteries. Equip the unit with an alarm which will supervise battery electrolight levels, produce a visual alarm when level reaches refill point. Unit shall have white housing.

B. Provide white wire guard on each unit in gymnasium.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to the manufacturer's recommendations. Emergency lighting battery units shall be hardwired to unswitched lighting circuit(s) serving area where units are located.

B. In Auditorium, mount units directly above exit signs where units are shown at same location as exit signs.

END OF SECTION 26 54 00

SECTION 27 00 00 – GENERAL COMMUNICATIONS

PART 1 - GENERAL

1.1 OTHER CONDITIONS

A. Applicable provisions of the General conditions, Supplementary Conditions, and Division 1, General Requirements, apply to the Work under this Section.

1.2 SCOPE OF WORK:

A. The work included under this specification consists of, but is not limited to, work as indicated on the drawings and hereinafter specified in Division 27. Without limiting the generality implied by the drawings an specifications, communications consists of furnishing all materials, accessories, tools, and labor required and incidental thereto, to provide:
   1. Integrated communications system.
   2. Data network facility.
   3. Auditorium sound reinforcement system.
   4. Commons sound reinforcement system.
   5. Low voltage cabling support system.

1.3 RELATED WORK:

A. Division 21: Fire Suppression, Division 22: Plumbing; Division 23: Mechanical; Division 26: Electrical; Division 28: Electronic Safety and Security.

B. See drawings and other sections for equipment requiring electrical service.

C. Painting (except factory-applied finishes on equipment) is specified elsewhere.

1.4 REFERENCE STANDARDS:

A. Make entire electrical installation in strict accordance with the requirements of all city, county, state, or federal codes of law having jurisdiction, the requirements and recommendations of the Board of Fire Underwriters, including all amendments and/or additions to said codes, laws, requirements, and recommendations and the requirements and recommendations of the Power Company. Applicable codes are as follows:
   1. NFPA 101 Life Safety Code.
   2. NFPA 72
   3. NFPA 70
   4. NFPA 90A
   5. NFPA 92A
   6. NFPA 13
   7. NFPA 13R
   8. NFPA 13D
   9. NFPA 14
   10. International Building Code
   11. International Fire Code

12. International Mechanical Code
13. NFPA 20

B. Should any work shown on the drawings or herein specified be construed a being contrary to or not conforming to the previously mentioned Codes, etc., bring it to the attention of the Architect before executing the work in conformity with the various codes,etc., without additional cost to the Owner, but not until the matter in question has been reviewed by the Architect.

C. Should any work shown on the drawings or herein specified be more rigid as to requirements than the requirements of the various codes, the drawings and specifications shall be used in executing the work.

D. File with proper authorities all necessary drawings as required by various codes, laws, ordinances, or other requirements.

E. Obtain and pay for all permits and for all required inspection certificates. Pay necessary fees.

1.5 WARRANTY-GUARANTEE

A. Warrant and guarantee that all work executed under this section of the specifications will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of the building. The above parties further agree that they will, at their own expense, repair and replace all such defective work and all other work damaged thereby which defective during the term of the warranty-guarantee.

1.6 ARCHITECTURAL DRAWINGS:

A. Refer to architectural drawings for details such as finishes, dimensions, materials, etc. Refer to drawings for door locations, door swings, partitions location, cabinet and counters, making proper allowances therefore. Refer to equipment plans for exact location of electrical connections which are dimensioned.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. Manufacturer's Data: For information only, submit 6 copies of manufacturer's specifications, descriptions, illustrations, and installation instructions for each type of manufactured product to include: Data network facility, integrated communications system, auditorium sound system, commons sound system, and low voltage cabling support systems intended for use on this project. The submittal shall consist of one or more brochures each containing only "one" copy of material describing the product. Several products may be included in each brochure.

B. Include manufacturer's certification as may be required to show compliance with these specifications. Indicate by transmittal form that a copy of each instruction has been distributed to the installer.

C. Furnish three complete sets of operating and maintenance instructions applying to equipment installed in conjunction with this contract; include parts lists, wiring diagrams, catalog data, stamped approval submittal data, and operational checkout data as called for in these specifications, bound in hardback binders. Instructions shall be submitted to the Architect for approval at least one month in advance of initial system start-up.

2.2 PRODUCTS

A. Materials shall not be ordered until architect's review of submittal material has been made. They shall be new and unused and the manufacturers standard product and the latest designs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The drawings which show the work included are diagrammatic only; the locations, routing, etc., of the various fixtures, items of equipment, wiring, etc., are approximate only. The entire installation is subject to such deviations, modifications, rerouting, etc., as may be necessary to meet the requirements of the architectural, structural, and other drawings; and also as necessary to obtain a proper coordination of the work with that of all other trades.

B. Carefully check and become familiar with the above-mentioned drawings, and frequently consult with all other trades so that the work may proceed as a harmonious whole.

C. Install concealed all wiring except where the Architect grants specified permission to run same exposed.

D. Installer shall defer the installation of all electrical fixtures liable to damage. After fixtures are permanently installed, completely protect against breaking, damage, or the depositing of any waste material therein until the system is accepted.

3.2 COORDINATION

A. Carefully check locations, layouts, and dimensions of all items to be installed under this section with the above-mentioned drawings, and coordinate with all trades affected.

B. Any work installed without properly checking and coordinating same as above provided, which as a result interferes with the proper installation of the work of other trades, is to be removed and properly reinstalled at contractor’s expense.

C. It is the installer's responsibility to notify well in advance, all trades affected, or any chases, recesses, etc., which may be required for the installation of the work. Should this be neglected, any cutting and/or patching required for such chases, recesses, etc., to be done at this contractor's expense.

3.3 PROTECTION AND CLEANING

A. Protect work, equipment, and materials at all times. Tightly cover and protect equipment against dirt, water, chemical, or mechanical injury. At final completion of all work to be thoroughly cleaned and delivered in a perfect unblemished condition.

B. Touch-up all damaged paint surfaces on equipment to match original paint.

3.4 INITIAL OPERATION OF EQUIPMENT

A. Give all equipment furnished in the contract an operational test prior to final acceptance. Assist the Owner in the initial operation when the owner operates the building and equipment. Instruct the owner's personnel in the proper operation and maintenance of all the equipment furnished under this section of the specifications.

3.5 FIRE-RATED WALL PENETRATIONS

A. Where conduit penetrates fire-rated walls, the space between the penetration item and the fire barrier wall shall be properly protected. The space adjoining the conduit penetration shall be filled with a material capable of maintaining the fire rating of the fire barrier, or it shall be protected by an approved device designed for this specific purpose. Where penetrating sleeves are used, the sleeves shall be solidly set in this fire barrier wall, and the space between the conduit and the sleeve shall be filled with a material capable of maintaining the fire resistance of the fire-rated wall.

END OF SECTION 27 00 00

SECTION 27 51 23 – INTEGRATED INTERCOM/DIGITAL TELEPHONE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section shall include a Microprocessor-Based Communications System. The components of the system shall include, but not limited to, the following:
   1. Administrative/Classroom Telephones.
   2. Speaker Assemblies, interior and exterior
   3. Digital LCD Readout units.
   4. Digital VOIP Telephone system
   5. Amplifiers.
   6. Battery Backup System
   7. Integrated Master Clock.
   8. Voice Mail
   9. GPS Clock System

B. This section shall include requirements for battery operated, wall mounted, GPS clocks.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.4 COORDINATION

A. Coordinate size and location of raceway system, and provisions for electrical power to equipment of this Section.

B. Coordinate Work of this Section with requirements of telephone service provider.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Products by manufacturers other than those listed in the specifications or on the drawings shall be submitted in accordance with section A01630-Substitutions of the specifications prior to bidding. Substitutions after bidding will not be approved.

B. The following specified system is a Rauland Telecenter intercom system with a Vertical MBX VOIP digital telephone system. This is a school system standard and must be interchangeable with systems installed in other Jefferson County Schools.

C. Available Manufacturers: Subject to compliance with requirements, clock manufacturers offering products that may be incorporated into the Work include the following:

GPS Clock System
Primex Wireless
Rauland

2.2 SYSTEM REQUIREMENTS

A. CENTRAL SWITCHING EXCHANGE

1. The central switch shall be a microprocessor controlled unit utilizing NMOS technology for memory, sensing, and logic control. The system shall lend itself to modular expansion to a total capacity of 358 stations. System shall allow future interface of media access and internet media control from the classroom.
2. The central switch shall utilize standard dual tone multi-frequency (DTMF) signaling for conformance with standard telephone practices. Those systems which utilize "smart" instruments which do not generate tones shall not be considered equal.
3. The system shall provide direct dialing, full duplex private telephone communications between all locations equipped with administrative telephones, feature telephones, and staff telephones.
4. The central switch shall provide an RS232C serial data port for connection to a computer for on-site diagnostics or via a modem to a remote computer for off-site diagnostic functions by a distributor or manufacturer personnel. It shall be possible to determine circuit and software faults via these diagnostics and facilitate remote software changes.

B. TELEPHONE COMMUNICATION OPERATION

1. The system shall provide telephone service to administrators and to classrooms as indicated on the drawings.

2. The telecommunication system shall provide for direct connection to central office telephone lines (CO Trunks). Initially the system shall be equipped for 16 trunks and wired for 32 trunks.

3. The system shall offer routing of inbound trunks for:
Attendant Answer Incoming (AAI)
Direct Inward Dialing (DID)

Direct Inward Line (DIL)
Private Direct Inward Line (PDIL)
Direct Inward System Access (DISA)

It shall also provide all standard Telco signaling to interface with other special services such as off-premise extensions (OPX), WATS, and CENTREX. Incoming Caller ID (ICLID) Shall also be supported on all inbound trunks.

4. The system shall be capable of operating with either loop start or ground start trunks for compatibility with existing and future utility services. The system shall also be capable of operating with E&M Tie Trunks (2 / 4 wire audio, Type I / II signaling).
5. The system shall offer full flexibility of software restrictions to station lines for external calling capability. Each station may be programmed as:

   Totally unrestricted
   Restricted access
   Long Distance Access
   Area Code Access
   Local Exchange Access
   No Access to Outside Trunks

6. The installed system must maintain toll restriction at the station level even when installed in CENTREX or other nested applications.
7. The system shall provide for Personal Identification Number (PIN) Codes for selected administrators. By dialing their PIN code at any system telephone, the administrator shall have access to the same capabilities assigned to their office telephone, regardless of the restrictions on the phone on which they are dialing.
8. The system shall provide discriminating ringing to enable the party receiving a call to distinguish between an internal call (long ring) and an outside call (two short rings).
9. The system shall provide automatic hunting for the first available trunk for an outside line request. Both Rotary and Linear hunting shall be supported. The system shall be capable of partitioning to provide complete control over access to outside trunks.
10. The system shall provide a "re-order signal" to unauthorized telephones attempting to select an outside trunk.
11. The system shall provide trunk queuing to allow a station to queue on a group of lines. When a line becomes available, the system will automatically ring the queued phone, and then re-transmit the dialed number. It shall not be necessary for the user to re-dial the desired number. The system shall provide a minimum of eight (8) trunk groups for the selection of outgoing lines. The system shall support a minimum of 16 Least Cost Routing List Tables. It shall probe possible to connect a CO trunk to the system which will directly ring a designated phone without the assistance of an operator, as for private line service. This call may be automatically routed to the attendant if it is not answered within a pre-determined time.
12. The system shall provide "Call Park" with remote pickup. This shall enable attendant to park call and permit paged party to remotely pick-up outside call from any telephone.

13. Staff (classroom) telephones shall be standard utility grade telephones with built-in network and ringers. Systems which do not provide standard telephones shall not be considered acceptable. All classroom telephones shall be equipped with a standard DTMF touch tone dial pad. A standard message waiting lamp shall also be provided at all stations. Provide two-wire balanced audio transmission with dial tone, ringing, and message waiting indication on all single line administrative and classroom telephones.
14. Provide conference calling and call transfer capability between all telephones. Transferred calls to busy extensions shall automatically return to the party which originated the transfer. If the originating set is equipped with a display, a "Busy" message shall appear on the display.
15 Provide executive override permitting assigned telephones to break into ongoing conversations.
16. The system shall allow any administrative telephone to remotely pick-up a call from any other ringing telephone.
17. The system shall enable any administrative telephone to remotely answer any outside call on an AAI programmed trunk by dialing a pre-determined code.
18. The system shall be capable of providing "night answer". When placing the system in "night answer" mode, it shall be possible for an incoming call on any AAI trunk to be directed to a pre-determined extension. Night mode shall also provide a tone over system speakers signaling key personnel to answer the incoming call at any administrative telephone. This shall provide the ability to answer calls throughout the facility.
19. The system shall provide "Flexible Class of Service" to allow changes in system features and functions during selected hours. It shall be possible to initiate Class of Service Changes either manually or automatically using the system's internal time base. Unless a request to the contrary is made by the owner, the system shall automatically make the Class of Service change each day at 4:30 PM and 6:30 AM. A minimum of four (4) independent program memory sets shall be provided. The choice of time of service change and active memory set selected shall be completely programmable. The following program changes in Class of Service shall be possible:

    Trunk type assignments.
    Trunk routing assignments.
    Restrictions on individual telephones including:
    Outside line access
    Toll restrictions
    Paging access restrictions
    Speaker first / phone first selection

20. The system shall provide Direct Inward System Access (DISA). It shall be possible to access central switch functions (i.e. all page, zone page, direct room dialing, monitoring etc.,) from any off-site touch tone telephone via an incoming CO Trunk. Only authorized individuals may use this feature by dialing the dedicated trunk number and then dialing the system function. It shall also be possible to restrict access to this function by means of a

password. The system shall provide Supervised Disconnect capability. When the Central Office sends a disconnect signal, the system shall automatically terminate the speaker connection.

21. The system shall be compatible with standard PBX signaling for direct connection to any existing or future PBX or VOIP Unit.
22. The system shall provide a "Student Phone" operation. A Student Phone shall be provided which shall allow students to make telephone calls home, to arrange for after school rides, etc. Complete control shall be maintained over that telephone including the following:
    a. The system shall be capable of enabling the telephones during specific, desired, time periods. It shall also be possible to enable and disable the Student Phone(s) manually from authorized administrative telephones.
    b. The system shall exercise complete, programmable toll restriction over the Student Phone. The system shall be capable of restricting the student phone to using only specific trunks.
    c. The system shall restrict the length of a conversation to a specific, programmable time period. If the conversation exceeds the time limit, a warning tone shall be sounded, followed ten seconds later by automatic disconnection.
    d. The system shall prevent any student from re-dialing a number, after a valid connection, from being redialed for a programmable time period.
    e. The Student Phone shall automatically be connected to an outside line. It shall not be necessary for the student to dial an access code to access a trunk. It shall not be possible to dial internal extensions or functions from the Student Phone.

23. The system shall be capable of providing "Music on Hold" to parties awaiting transfer.
24. Other features to be provided by the system shall include:
    Call Forward (No Answer, Busy, Follow Me)
    Call Back - Busy Station
    Station Message Detail Recording (SMDR)
    System Speed Dial
    Senderized Dialing
    System Clock

25. The system shall provide facilities for both on-premise and off-premise computer linkage using standard modems.
26. Provide a built-in, auto-answer modem allowing off-premise troubleshooting and off-premise programming. Provide necessary outside line port for off-premise troubleshooting.
27. Voice mail system shall be 8 port digital with unlimited mail boxes with 100 hours storage and auto attendant feature. Vertical 4500-80

C. INTERCOM AND PUBLIC ADDRESS OPERATION

1. Each classroom shall be equipped with a ceiling or wall mounted speaker and a wall mounted telephone intercom set. Refer to the plans for ceiling or wall mounted speaker locations.
2. The central switch shall be supplied with a two-way amplified communication path to locations equipped with speakers. The intercom amplifier shall be

capable of delivering at least twelve (12) watts RMS and shall contain an automatic level control. Provide two channels.

3. System shall provide facilities for calling a staff (classroom) station by dialing the station number. The system shall allow for two way speaker communication in classrooms or private telephone type communication. System shall have two communication paths to each classroom. This will allow all call announcements, class change signals, two-way speaker conversation and telephone handset communication at the same time.
4. The system shall provide the capability of assigning speaker locations to any one or more of the eight (8) software programmable zones for zone paging or time tone signal reception. Systems using a mechanical means (such as dip switches or jumpers) to assign zones shall not be acceptable.
5. Provide for the distribution of emergency announcements and for the distribution of manually activated tones to all locations with speakers from any authorized telephone.
6. The system shall be equipped with power amplifiers to facilitate the distribution of All-Call Announcements, Zone Paging, Emergency Evacuation Tones and Program Material. The power amplifiers shall have an audio output rated at a minimum of 250 watts.
7. The system shall have voice mail, auto attendant with four ports and 35 hours storage. Programming shall be windows based with remote interface for offsite access and programming. User greetings customized to allow availability based on time of day, day of week or as needed.
8. The system shall provide facilities for digital readout displays upon which incoming calls are identified by their designated numbers. The display shall show visually, in the order received, three (3) calls at a time. Emergency calls shall override normal calls and shall annunciate with the letters "EMER" and the calling station number.

C. PROGRAM DISTRIBUTION OPERATION

1. The system shall provide facilities to distribute program material.

D. MASTER CLOCK REQUIREMENTS

1. The system shall have the ability to operate solely as a master clock. Capacity for storing 550 events and up to 100 holidays in Non-volatile memory. Ability to review edits and deletes events. Review of events from any entered time of day. Events shall be programmable to any one or all of eight (8) zone circuits. Selection of any one of eight (8) schedules to allow flexibility due to seasonal changes or special events. Fully automatic holiday program execution. Bells can be silenced or special schedules can be implemented. Normal bells will resume after the holiday period. User-programmable Automatic Daylight Savings Time Change. Programmable Music-on-Class-Change, when the system is equipped with program distribution facilities. This feature shall be programmable from 1 to 15 minutes. Separate bells duration for each zone circuit. Latched operation of zones to control lighting or other devices. Ability to test all output zones circuits. Interface with all types of secondary slave clocks whether synchronous wired, electronic, or minute-impulse types. This shall be accomplished without the use of external synchronous adapters. Accumulation of down time during power outage to reset slave clocks, both

minute-impulse and synchronous types after the power has been restored. User-programmable custom slave clock correction. Output relays rated at 5 amperes shall be provided on all eight (8) zone circuits. Crystal-controlled time base for assured accuracy. Lithium battery will provide not less than 5 years battery back up for timekeeping function. Permit interface to a personal computer/printer to allow remote programming, diagnostics, and call logging. 16 different tones available

2.3 COMMUNICATION UNITS

A. Administrative Telephones shall have 24 feature buttons with fully integrated speaker-phone and LCD display. SBX320 24 button telephones

B. Classroom (Staff) Telephones shall have one line phone with mute, message wait lamp, flash button, hold button, redial button, hi/lo ringer control, data jack and a lead control. Wall mount where indicated on plans. Starplus SP2801-08 or equal.

2.4 SPEAKERS

A. Ceiling speakers shall be a Rauland BAFKIT1X2CS or approved equal. It shall be an 8@ permanent magnet seamless cone type, with an additional cone provided to extend high frequency response. Frequency range shall be 65 to 17,000Hz; ceramic magnet weight shall be at least 5 oz. (141.75 g); axial sensitivity shall be 93dB at 1 meter with 1 watt input; power rating shall be 8 watts RMS; voice coil impedance shall be 8 ohms and shall measure .75@ (1.91 cm) in diameter; speaker depth shall be 2.75@ (6.99 cm). The speaker shall be equipped with a universal line matching transformer for 25V/70V output line tapped at 5/16, 5/8, 1-1/4, 2-1/2 and 5 watts. Assembly shall be tile replacement speaker with white epoxy finish 2x2 lay in tile support. Unit shall be a complete assembly listed for return air plenums.

B. Recessed wall mounted speakers shall be a Rauland ACC1003 or approved equal. It shall be an 8@ permanent magnet seamless cone type, with an additional cone provided to extend high frequency response. Frequency range shall be 65 to 17,000Hz; ceramic magnet weight shall be at least 5 oz. (141.75 g); axial sensitivity shall be 93dB at 1 meter with 1 watt input; power rating shall be 8 watts RMS; voice coil impedance shall be 8 ohms and shall measure .75@ (1.91 cm) in diameter; speaker depth shall be 2.75@ (6.99 cm). The speaker shall be equipped with a universal line matching transformer for 25V/70V output line tapped at 5/16, 5/8, 1-1/4, 2-1/2 and 5 watts. Provide square flush mounted wall baffle and back box.

C. Exterior recessed wall mounted speakers shall be a Rauland ACC1008 or approved equal. It shall be an 8@ permanent magnet seamless cone type, with an additional cone provided to extend high frequency response. Frequency range shall be 65 to 17,000Hz; ceramic magnet weight shall be at least 5 oz. (141.75 g); axial sensitivity shall be 93dB at 1 meter with 1 watt input; power rating shall be 8 watts RMS; voice coil impedance shall be 8 ohms and shall measure .75@ (1.91 cm) in diameter; speaker depth shall be 2.75@ (6.99 cm). The speaker shall be equipped with a universal line matching transformer for 25V/70V output line tapped at 5/16, 5/8, 1-1/4, 2-1/2 and 5 watts. Provide square flush mounted vandal-Proof wall baffle and backbox.

2.5 ACCESSORIES

A. Provide a Caller ID interface for Central Office Lines.

B. ITW Linx M4KSU and MCO8110 surge suppressor shall be provided for all CO lines and AC Circuits.

C. Provide a rack mounted UPS system with 8 outlets, diagnostic LEDs, built-in serial port, 12' cord, surge protection and Automatic Voltage Regulation (AVR). AVR corrects brownouts and over-voltages without draining battery power. The system shall be sized to allow the equipment to operate for two hours after loss of normal building power. Tripp-Lite or equal. 1000 watts

D. The equipment shall be contained in an upright rack, Rauland Model RP1103 or approved equal, providing at least 61 1/4" total of panel mounting space. The rack shall be minimum 65 7/16"high, 22 3/8" wide and 18 1/2" deep. The rack shall be constructed of at least 16 gauge steel, properly reinforced for maximum strength and durability. It shall have a hinged and key-locking rear door providing authorized personnel with easy access to the equipment and be finished in textured flat black baked enamel. Provide blank inserts over unused space.

E. All Call Amplifier , 250 watt rms with 25-volt line.

2.6 COMMUNICATIONS TERMINAL SPACE (CTS)

A. CTS shall consist of a 4'-0" x 8'-0" x 3/4" plywood, mount as required by the structure. Provide Unistrut PIOOO strip above and below to secure conduit. Plywood shall be painted to match existing walls.

2.7 CABLING

A. Intercom speaker cables shall be twisted shielded two conductor 22 gauge stranded cable.

B. Telephone cable shall be four pair 24 gauge Category 5E (enhanced) cable minimum.

C. Provide voice grade cabling from Digital Telephone equipment to Intercom equipment as recommended by the manufacturer.

2.8 COVERPLATES AND JACKS

A. Coverplates shall be single-gang modular ports. Coverplate shall match other devices in the space. Provide Category 3 Voice jacks for intercom phone connections. Jacks shall be red in color for voice activations.

B. For floor boxes provide 106 style frame and coverplate. Frame shall have four modular ports. Provide Category 3 Voice jacks for intercom phone connections. Jacks shall be red in color for voice activations.

2.9 SPEAKER GROUPING

A. Speakers located in corridors and common areas shall be grouped into one zone to allow for paging.

B. Speakers located in the Dining/Commons and Platform areas shall be grouped into one zone to allow for paging.

C. Speakers located in classrooms, offices, work areas, etc. shall not be grouped.

D. All other areas shall be grouped accordingly.

2.10 GPS DIAL CLOCKS

A. GPS dial clock shall be a 12.5" diameter black plastic case with shatter-resistant safety crystal, white face and black numbers. Primex 14155

B. The GPS Receiver shall be Primex 14000 1 watt with external antenna furnish 14401 satellite transmitter as required. FCC licensing shall be furnished as part of bid package

PART 3 - EXECUTION

3.1 INSTALLATION

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts. All cabling shall be terminated on 66 type distribution blocks and labeled. Cross-connect wire shall be used for all interconnect between station and field wiring.

B. Wiring Method: All cabling shall be installed open above lay-in ceiling and in conduit where concealed in walls or floors.

C. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

F. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

G. The telephone companies interface shall be extended from the de-mark to the intercom/telephone system with minimum 25 pair cable with 10% spares. Lightning protection shall be provided for all central office lines.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 16 Section "Grounding and Bonding."

3.3 SERVICE AND MAINTENANCE

A. The contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.

B. The contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments that will facilitate the training of individuals in the operation of this system. Operator Manuals and Users Guides shall be provided at the time of this training.

END OF SECTION 27 51 23

SECTION 28 00 00 - GENERAL ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 OTHER CONDITIONS

A. Applicable provisions of the General conditions, Supplementary Conditions, and Division 1, General Requirements, apply to the Work under this Section.

1.2 SCOPE OF WORK:

A. The work included under this specification consists of, but is not limited to, work as indicated on the drawings and hereinafter specified in Division 28. Without limiting the generality implied by the drawings an specifications, electronic safety and security consists of furnishing all materials, accessories, tools, and labor required and incidental thereto, to provide:
   1. Fire alarm system.
   2. CCTV system.

1.3 RELATED WORK:

A. Division 21: Fire Suppression, Division 22: Plumbing; Division 23: Mechanical; Division 26: Electrical; Division 27: Communications.

B. See drawings and other sections for equipment requiring electrical service.

C. Painting (except factory-applied finishes on equipment) is specified elsewhere.

1.4 REFERENCE STANDARDS:

A. Make entire electrical installation in strict accordance with the requirements of all city, county, state, or federal codes of law having jurisdiction, the requirements and recommendations of the Board of Fire Underwriters, including all amendments and/or additions to said codes, laws, requirements, and recommendations and the requirements and recommendations of the Power Company. Applicable codes are as follows:
   1. NFPA 101 Life Safety Code.
   2. NFPA 72
   3. NFPA 70
   4. NFPA 90A
   5. NFPA 92A
   6. NFPA 13
   7. NFPA 13R
   8. NFPA 13D
   9. NFPA 14
   10. International Building Code
   11. International Fire Code
   12. International Mechanical Code
   13. NFPA 20

B. Should any work shown on the drawings or herein specified be construed a being contrary to or not conforming to the previously mentioned Codes, etc., bring it to the attention of the Architect before executing the work in conformity with the various codes, etc., without additional cost to the Owner, but not until the matter in question has been reviewed by the Architect.

C. Should any work shown on the drawings or herein specified be more rigid as to requirements than the requirements of the various codes, the drawings and specifications shall be used in executing the work.

D. File with proper authorities all necessary drawings as required by various codes, laws, ordinances, or other requirements.

E. Obtain and pay for all permits and for all required inspection certificates. Pay necessary fees.

1.5 WARRANTY-GUARANTEE

A. Warrant and guarantee that all work executed under this section of the specifications will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of the building. The above parties further agree that they will, at their own expense, repair and replace all such defective work and all other work damaged thereby which defective during the term of the warranty-guarantee.

1.6 ARCHITECTURAL DRAWINGS:

A. Refer to architectural drawings for details such as finishes, dimensions, materials, etc. Refer to drawings for door locations, door swings, partitions location, cabinet and counters, making proper allowances therefore. Refer to equipment plans for exact location of electrical connections which are dimensioned.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. Manufacturer's Data: For information only, submit 6 copies of manufacturer's specifications, descriptions, illustrations, and installation instructions for each type of manufactured product to include: Fire alarm and CCTV system intended for use on this project. The submittal shall consist of one or more brochures each containing only "one" copy of material describing the product. Several products may be included in each brochure.

B. Include manufacturer's certification as may be required to show compliance with these specifications. Indicate by transmittal form that a copy of each instruction has been distributed to the installer.

C. Furnish three complete sets of operating and maintenance instructions applying to equipment installed in conjunction with this contract; include parts lists, wiring diagrams, catalog data, stamped approval submittal data, and operational checkout data as called for in these specifications, bound in hardback binders. Instructions shall be submitted to the Architect for approval at least one month in advance of initial system start-up.

2.2 PRODUCTS

A. Materials shall not be ordered until architect's review of submittal material has been made. They shall be new and unused and the manufacturers standard product and the latest designs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The drawings which show the work included are diagrammatic only; the locations, routing, etc., of the various fixtures, items of equipment, wiring, etc., are approximate only. The entire installation is subject to such deviations, modifications, rerouting, etc., as may be necessary to meet the requirements of the architectural, structural, and other drawings; and also as necessary to obtain a proper coordination of the work with that of all other trades.

B. Carefully check and become familiar with the above-mentioned drawings, and frequently consult with all other trades so that the work may proceed as a harmonious whole.

C. Install concealed all wiring except where the Architect grants specified permission to run same exposed.

D. Installer shall defer the installation of all electrical fixtures liable to damage. After fixtures are permanently installed, completely protect against breaking, damage, or the depositing of any waste material therein until the system is accepted.

3.2 COORDINATION

A. Carefully check locations, layouts, and dimensions of all items to be installed under this section with the above-mentioned drawings, and coordinate with all trades affected.

B. Any work installed without properly checking and coordinating same as above provided, which as a result interferes with the proper installation of the work of other trades, is to be removed and properly reinstalled at contractor’s expense.

C. It is the installer's responsibility to notify well in advance, all trades affected, or any chases, recesses, etc., which may be required for the installation of the

electrical work. Should this be neglected, any cutting and/or patching required for such chases, recesses, etc., to be done at this contractor's expense.

3.3 PROTECTION AND CLEANING

A. Protect work, equipment, and materials at all times. Tightly cover and protect equipment against dirt, water, chemical, or mechanical injury. At final completion of all work to be thoroughly cleaned and delivered in a perfect unblemished condition.

B. Touch-up all damaged paint surfaces on equipment to match original paint.

3.4 INITIAL OPERATION OF EQUIPMENT

A. Give all equipment furnished in the contract an operational test prior to final acceptance. Assist the Owner in the initial operation when the owner operates the building and equipment. Instruct the owner's personnel in the proper operation and maintenance of all the equipment furnished under this section of the specifications.

3.5 FIRE-RATED WALL PENETRATIONS

A. Where conduit penetrates fire-rated walls, the space between the penetration item and the fire barrier wall shall be properly protected. The space adjoining the conduit penetration shall be filled with a material capable of maintaining the fire rating of the fire barrier, or it shall be protected by an approved device designed for this specific purpose. Where penetrating sleeves are used, the sleeves shall be solidly set in this fire barrier wall, and the space between the conduit and the sleeve shall be filled with a material capable of maintaining the fire resistance of the fire-rated wall.

END OF SECTION 28 00 00

SECTION 28 17 00 - CCTV SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

A. Furnish and install a complete CCTV system as describe in this specification and as shown on the plans. Provide all necessary labor and materials for a complete system.

1.3 QUALITY ASSURANCE

A. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The contractor shall be a licensed CCTV Alarm contractor as required by the state of Tennessee. A copy of this license shall be submitted with the submittal package.

B. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts

1.4 COORDINATION

A. Coordinate size and location of raceway system, and provisions for electrical power to equipment of this Section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Products by manufacturers other than those listed in the specifications or on the drawings will be approved if they meet the specifications.

B. The following specified system is by Openeye Network Video and shall be the minimum requirements. It is the responsibility of the bidder to insure the proposed system meets or exceeds the equipment specified.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering IP CCTV system equipment which may be incorporated in the work include the following:

Open Eye, Axis, and Arecont Vision

D. Any revision or addition to the wiring required by substitute equipment shall be the responsibility of the substituting contractor.

2.2 MEGA PIXEL IP CAMERAS

A. The dome IP camera shall include 2 MP 1080p resolution. The camera shall provide a 4 mm lens with MPEG/JPEG compression format. The housing shall be ceiling or wall mounted on an arm for wall mounting. The camera shall be POE powered. Camera shall include a SD Card backup Slot and 2 way-audio.

Examples:

Dome mounted cameras	Openeye CM-611
Wall mount	Openeye CA-410W
Exterior Vandal Camera	Openeye CM-715

B. Door intercom and camera: Furnish and install a Aiphone network viewing intercom and camera system from the office to the front entry to allow control of door entry system. System shall allow control of door strike hardware. Aiphone JAS-2MCD with JKW-P Network adapter.

2.3 MONITORS

A. The VGA Flat Panel Monitors shall be 32-inch LCD color monitor and 1280X1024 of resolution. Example: Vizeo 32 LCD, Furnish a monitor with each NVR.

2.4 NETWORK VIDEO RECORDERS

A. Network Video Recorders shall be furnished for each group of 16 Cameras. The NVR shall have 4-TB -480FPS hard drive capacity, TCP/IP address for Ethernet viewing. Remote viewer software to allow live or recorded video to be viewed. The search feature shall allow camera, time date and alarm search. 16 channel video/audio, D1 real time DVR or Analog Ports, 16 channels audio inputs. Rack mounted with IR Remote Control. Furnish rack mounted UPS for each DVR 1000 Watt. Furnish CMS software to allow viewing of several NVR for central video management.

Example
Openeye OE5-N3U16

B. POE Network Switch for cameras: 24 Port Web Ming 10/100/1000 ENET all POE Port Switch. Netgear GS724TP smart switch with POE. Furnished with web based management tool for deployment.

C. Patch panel's furnish and install Leviton or equal Category 6 patch panels to terminate all camera cable with patch cords for connection to POE Switch. Leviton 6910G-U24 with 6d460-03E three foot patch cables.

2.5 RACK

A. Free Standing Rack Hubbell HPW84RR19 with HLS1012 Ladder Rack and HLX0612 wall bracket secured with HJJB J bolts.

2.6 CABLING

A. Cabling to each camera shall be Cat 6 cable shall be color coded to distinguish it from other category cable used for network devices. .

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the CCTV System shall be in strict compliance with manufacturer's recommendations, Local, State and National Codes.

3.2 FIELD QUALITY CONTROL

A. Pre-testing: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved.

3.3 SERVICE AND MAINTENANCE:

A. The contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.

B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

3.4 IN-SERVICE TRAINING:

A. The contractor shall provide a minimum of four hours of in-service training with this system. Operator Manuals and Users Guides shall be provided at the time of this training.

END OF SECTION 28 17 00

SECTION 28 31 00 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This specification provides the requirements for a fire alarm life safety control system. The system shall include, but not be limited to: control panel, alarm initiating and indicating peripheral devices, conduit, wire and accessories required for a complete operational system. The equipment shall be as supplied by Siemens Faraday as specified herein. All work in this section of the specifications shall be coordinated with the hardware, mechanical and fire sprinkler sections of this specification as indicated herein and contract drawings.

1.2 STANDARDS

A. The equipment and installation shall comply with the current applicable provisions of following standards;

NATIONAL ELECTRIC CODE, ARTICLE 760

NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS:
NFPA 70 National Electrical Codes
NFPA 71 Central Station Signaling Systems Protected Premises Unit
NFPA 72 Protective Signaling Systems
NFPA 72E Automatic Fire Detectors
NFPA 101 Life Safety Code

LOCAL AND STATE BUILDING CODES

ALL REQUIREMENTS OF THE LOCAL AUTHORITY HAVING JURISDICTION

1.3 GENERAL REQUIREMENTS

A. All equipment proposed as manufactured by Siemens Faraday. These are school system standards and are the only approved systems for this project. Existing Faraday system shall be maintained through out the construction time. The Faraday MPC 7000 Panel installed in the renovation shall be capable of networking to the Faraday MPC6000 in the Field House and Stadium.

1.4 EQUIPMENT MANUFACTURERS

A. All references to manufacturer's or supplier's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

1.5 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. All equipment and material shall be new and unused, and listed by underwriter's laboratories for the specific intended purpose. All control panel components and field peripherals shall be designed for continuous duty without degradation of function or performance for a minimum time period, to meet the manufacturer's specified warranty period. All equipment covered by this specification or noted on installation drawings shall be the proper equipment suited for the application. UL listed as compatible components of the system and shall be provided by a single manufacturer.

1.6 APPROVED EQUIPMENT SUPPLIERS

A. Equipment and materials shall be supplied by an approved Siemens Faraday factory distributor. It will be the responsibility of the distributor to ensure proper specification adherence for system operation, final connection, test, turnover, warranty compliance, and after-market service. The distributor of the equipment specified shall be factory trained and certified by the manufacturer.

PART 2 - CONTROL EQUIPMENT

2.1 CONTROL PANEL AND SYSTEM DESCRIPTION

A. The control panel shall be a Faraday Inc. MPC 7000 combination system analog/addressable "software" type zones and shall provide all modules necessary for operation specified herein and be capable of expansion to 1008 modules with the following capacities:
   1. Combined conventional and analog/addressable initiating zones - 504
   2. Combined conventional and analog/addressable indicating and/or control relay circuits – 252 per Loop Total 4 loops
   3. Power supply capacity – 8 amps @ 24 VDC.
   4. Provide remote power boosters for all remote signal boosters as required.

B. Central Processing Unit (FDLC): The FDLC module shall communicate with, monitor, and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported by the central processing unit as a trouble status. The CPU shall contain and execute all standard and custom programs for specific action to be taken if a fire situation is detected by the system. Such programs shall be held in non-volatile, field programmable Eprom memory, and shall not be lost and/or altered even if system primary and secondary power failure occur. The central processing unit shall have an integral, 80-character, alpha-numeric, back lighted LCD display. The display shall feature system status, functions, custom field assigned messages, prompting displays for field programming and normal display of date and time. The display shall provide automatic scrolling of multiple system status. All system functions shall be field programmable by entry of assigned software security code. Separate codes shall be provided for

user/programmer functions. System programming shall be accomplished via the keypad unit or by use of a communications interface module and a laptop computer. Systems requiring a peripheral programming device shall not be acceptable.

2.2 VOICE EVACUATION SYSTEM

A. The fire alarm system shall include six channel of multiplex simultaneous voice evacuation and communication capability with pre-recorded digital message repeater unit, one-way paging over all active system speaker devices. The microphone module shall contain one (1) amber microphone trouble led. The system shall be configured for each pod to have a separate speaker circuit with floor above and below programming. Provide distributed 100 watt multiplex booster panels throughout the CTC closets to provide local distributed EVAC with the remote strobe booster panels.

B. A digital message repeater unit shall be provided as an integral part of the MPC 7000 voice evacuation panel. The digital message module shall provide for the playing of a prerecorded voice evacuation messages over all activated speaker devices during an alarm condition. The output format shall be set for a continuous cycle of tone followed by message followed by tone, repeated until silenced or reset. Any live microphone or telephone patch operations shall automatically override the prerecorded message or system tone transmissions. In the case of a failure of the digital voice unit, the system shall automatically revert to the system tone and /or live output format. The prerecorded message shall be contained in non-volatile Eprom memory. The panel shall have four custom messages as selected by the owner.

C. The audio power amplifier(s) shall provide the output necessary to drive audible speaker devices in the MPC EVAC system. The audio amplifiers shall be constantly supervised for loss of power and/or signal output. These amplifiers shall also contain built-in protection against line surges, overloads, short circuits and abnormal heat buildup. Primary operating power shall be 120 VDC /60 HZ and standby power from a 24 VDC battery set. The unit shall be capable of delivering 200 watts continuously at 25 V RMS. Provide back up amplifiers for each circuit.

D. The system shall be capable to have firefighter's telephone circuits (up to a maximum of 16) which provide two-way handset communications which can be initiated from either the master handset located at the main FACP or from remote portable handsets or warden stations. Means shall be provided to allow for the annunciation of the circuit on which the call has originated. In addition, the telephone system shall have full patch intercom features for linking the master and remote phone communications into the activated speaker circuits. The firefighter's telephone system shall function in party line mode or six active phones circuits. Provide handsets for 50 % of all active fire mans phone jacks with storage cabinets.

PART 3 - PERIPHERAL EQUIPMENT

3.1 SERIAL REMOTE LCD DISPLAY/CONTROLLER

A. The U.L. listed, remote LCD display/controller shall provide a complete remote visual LCD system status display and remote system control center for the fire alarm system control panel. The unit shall include an integral system trouble unit with trouble buzzer and buzzer silence switch. A remote lamp test switch shall also be provided. The visual system status displays shall be accomplished via an 80 character (40 x 2) alpha-numeric LCD back-lighted display. All system alarm and trouble status messages shall be reported in an auto-scrolling format with automatic alarm message priority override. Additional individual red SYSTEM ALARM and yellow SYSTEM TROUBLE discrete LED's shall be included on the remote LCD display/controller. A green POWER ON LED and the current time and date shall display normal status of the system. The remote system control functions shall be accomplished via a five (5) switch membrane pad located on the front of the unit. Switches shall be provided for unit buzzer silence and unit lamp test. By entering the appropriate five (5) digit access code, a user may gain access to the remaining system control switches to allow for remote system reset, system alarm silence and system drill test/recall functions. The system control switches may be independently enabled or disabled via programming jumpers on the rear of the unit at the time of installation for each particular remote LCD display/controller. The remote LCD display/controller shall be available in red finish and shall mount to a standard 5-gang deep electrical box. Power, supervision and custom alpha-numeric messages shall be accomplished via two (2) 2-conductor twisted pair, non-shielded cables. The unit shall be powered from the main control panel and supported during AC power failure by the system backup battery set. Furnish per plans.

3.2 DIGITAL COMMUNICATOR

A. The UL listed, DACT a four channel slave digital communicator. Remote programming up/downloading, dual line interface, automatic 24 hr test with built in dual line seizure. UDACT shall be a plug in module for installing in fire panel. **Provide first year monitoring with this contract. Owner to furnish two telephones lines per NFPA and local fire codes.**

3.3 ANALOG/ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS (Model 8710 with 8853 base or 8715 audible base)

A. The area smoke sensors shall connect with two (2) wires to one of the fire alarm control panel signaling line circuit loops. The sensors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. The sensors shall be ceiling mount with a twist-lock base and shall provide a test means which will simulate an alarm condition and report that condition to the control panel. This test may be initiated at the sensor itself by

activation of a magnetic switch or may be activated on command from the control panel. The sensors shall provide address setting on the sensor head through the use of rotary decimal switches. Each sensor shall store internally an identifying code which the control panel shall use to identify the type of sensor. The unit shall contain dual alarm and power LED's. Both LED's shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Upon detection of smoke (and optionally, verification of smoke), both LED's will be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. The alarm verification operation shall be enabled or disabled on individual smoke sensors through the programming of the control panel. An output connection shall be provided in the base to connect an external remote LED alarm indicator. The sensor sensitivity shall be set, tested (NFPA 72E) and maintained through the fire alarm control panel and shall be adjustable in the field through field programming of the system. Provide 8715 audible bases with temporal or steady 85 db sound level as required for local code requirements.

B. Furnish and install as indicated on the drawings a photo thermal assist smoke detector (Model 8713 with base 8853). The smart smoke detector shall be programmed for the environment it is installed in to compensate for harsh conditions. The fire smart detector shall utilize a microprocessor on board EEPROM for self diagnostic and programming.

3.4 ANALOG/ADDRESSABLE DUCT SMOKE SENSOR HOUSING

A. Provide and install where shown on plans duct smoke sensor housings which can be used with either photoelectric or ionization type analog/addressable detectors. Each housing unit shall be installed with properly sized air sampling tubes. If shutdown of air handling units is required, provide duct detector housing 8717 with integral relay contacts. Provide remote 8727 LED for each duct detector.

3.5 PHOTOELECTRIC AREA SMOKE DETECTORS

A. The contractor shall furnish and install photoelectric type smoke detectors where indicated on the plans. The combination detector head and base shall be U.L. listed compatible with the fire alarm control panel and U.L. listed to Standard 268. The unit shall be capable of two-wire or four-wire operation by using the applicable mounting base which shall be capable of supporting a remote LED alarm indicator. The base shall have a built-in tamper resistant feature to prevent disconnection from the system. Wiring connections to the detector base shall be such that removal of a detector head from a base will cause a system trouble. The detectors shall contain an LED that latches on steady as an indication of its alarmed condition and all wiring connections shall be made to terminals.

3.6 DUCT SMOKE DETECTORS

A. The contractor shall furnish and install duct smoke detectors where shown on the plans. The housing unit and detector head shall be U.L. Listed compatible with the fire alarm control panel and U.L. Listed to standard 268A for use in an air handling system. The unit shall operate at duct air velocities from 300 to 4000 feet per minute. The housing shall employ a separate head and base design to allow for the use of either photoelectric or ionization heads. It shall be possible to test the duct smoke detector at the housing itself or through the use of a remote test station. Terminal connections shall be provided for all wiring and air sampling tubes shall be capable of being installed after the housing is mounted.

3.7 REMOTE ALARM LED INDICATOR

A. Remote Alarm Indicators shall provide a red LED on a single gang plate which indicates the alarm status of the associated area smoke and/or air duct detector (one each per duct detector).

3.8 ANALOG/ADDRESSABLE THERMAL SENSOR (Model 8712 with 8853 base)

A. Heat sensors shall connect with two (2) wires to one of the fire alarm control panel signaling line circuit loops. The detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of thermal measurements. The sensors shall be ceiling mount with a twist-lock base and shall provide a test means which will simulate an alarm condition and report that condition to the control panel. This test may be initiated at the sensor itself by activation of a magnetic switch or may be activated on command from the control panel. The sensors shall provide address setting on the sensor head through the use of rotary decimal switches. Each sensor shall store an internally identifying code which the control panel shall use to identify the type of sensor. The unit shall contain dual alarm and power LED's. Both LED's shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Upon detection of appropriate thermal conditions, both LED's will be placed into steady illumination by the control panel, indicating an alarm condition. An output connection shall be provided in the base to allow connection of an external remote LED alarm indicator. The heat sensors shall be available in fixed temperature 135-degree model and combination fixed temp/rate of rise model.

3.9 NON-CODED ADDRESSABLE MANUAL FIRE ALARM STATIONS, (8700S)

A. Manual fire alarm stations shall be addressable, field selectable non-break glass. The manual stations shall be constructed of die formed, red finished Lexan with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one-half inch size or larger. Stations shall be suitable for surface mounting on a matching backbox or semi-flush mounting on a standard single gang box or switch plate and shall be U.L. listed.

When called for on contract drawings, provide and install a weatherproof version of the manual station. Provide STI Stopper covers for all pull stations.

3.10 SPEAKER STROBES AND INDICATING APPLIANCES
(SE-MC-W and SE-W speaker only units)

A. The visual indicating appliances (strobes) shall be U.L. Listed and comply with UL1971 and UL 464 requirements. The appliances shall be polarized and operate from 24VDC supplied by the fire alarm control panel. Visual indicating devices shall provide a xenon flashtube with solid state circuitry for maximum reliability and efficiency. The bottom of the lens for the strobe unit shall be translucent white with the word FIRE in red letters. The top strobe composition shall be of clear Lexan. Strobe shall have a minimum effective luminous intensity rating of 15/75 candela with four selectable values and deliver a flash rate of approximately 1 flash per second. Units shall be installed as indicated on the plans and specifications. The speaker shall be dual voltage 25/70VRMS field selectable 1/8 to 2 watts. Mounting shall be to a standard 4”x2-1/8 electrical box.

3.11 VISUAL ALARM INDICATING APPLIANCES (ZR Series Strobes)

A. The visual indicating appliances (strobes) shall be U.L. Listed and comply with UL1971 and UL 464 requirements. The appliances shall be polarized and operate from 24VDC supplied by the fire alarm control panel. Visual indicating devices shall provide a xenon flashtube with solid state circuitry for maximum reliability and efficiency. The bottom of the lens for the strobe unit shall be translucent white with the word FIRE in red letters. The top strobe composition shall be of clear Lexan. Strobe shall have a minimum effective luminous intensity rating of 15/75 candela with four selectable values and deliver a flash rate of approximately 1 flash per second. Units shall be installed as indicated on the plans and specifications.

3.12 ANALOG/ADDRESSABLE MONITOR MODULE (Model 8702)

A. Monitor modules shall be provided to connect one (1) supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device, including 4-wire smoke detectors) to one of the fire alarm control panel signaling line circuit (SLC) loops. The monitor module shall mount in a 4-inch square, 2-1/8" deep electrical box, or to a surface mounted backbox. The IDC zone may be wired for Class "A" OR Class "B" operation. The monitor module shall provide a test means that will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the monitor module itself by activating a magnetic switch or may be activated remotely on command from the control. The monitor module shall provide address settings using rotary decimal switches and shall store an internal identifying code which the fire alarm control panel shall use to identify the type of device. An LED shall be provided which shall flash under normal conditions, indicating that the monitor is operational and in regular communication with the control panel.

3.13 ANALOG/ADDRESSABLE MINI-MONITOR MODULE (Model 8701)

A. Monitor modules shall be provided to connect one (1) supervised zone of conventional alarm initiating devices (any N.O. dry contact device, including 4-wire smoke detectors) to one of the fire alarm control panel signaling line circuit (SLC) loops. The mini-monitor module shall be no larger than 2-3/4" X 1-1/4" X 1/2" to allow for ease of installation in hard to reach areas. The IDC zone may be wired for Class "B" operation only. The mini-monitor module shall provide address settings using rotary decimal switches and shall store an internal identifying code which the fire alarm control panel shall use to identify the type of device.

3.14 ANALOG/ADDRESSABLE CONTROL MODULE (Model 8704)

A. Control modules shall be provided to supervise and control the operation of one conventional indicating appliance circuit (NAC) of compatible, 24VDC powered, polarized audio/visual indicating appliances. The control module shall mount in a standard 4-inch square, 2-1/8" deep electrical box or to a surface mounted backbox. The NAC may be wired for Class "A" or Class "B" indicating appliance circuit (up to 48 watts of audio speaker or 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal) operation or as a dry contact (Form C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements and to insure that 100% of all auxiliary relay or NAC's may be energized at the same time on the same pair of wires. Audio/visual or speaker power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, U.L. Listed remote power supply or audio amplifier. The control module shall provide address settings using rotary decimal switches and shall store an internal identifying code which the control panel shall use to identify the type of device. A LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.15 REMOTE NAC EXPANDES (RSE 300)

A. Six-amp at 24 volt dc and four each notification appliance circuits. Provide as required for each pod.

PART 4 - SYSTEM OPERATION

4.1 ONE MAN TEST OPERATION

A. The system shall include a "Quick Test" feature, which will allow a single person to test all initiating devices and indicating appliances in a system without returning to the panel to reset the system. This "Quick Test" mode shall cause the indicating appliance circuits to activate in response to initiating device operation according to the system programming. Modes of testing which do not reflect system programming will not be acceptable. A special password shall be required to enter the "Quick Test" mode.

4.2 SYSTEM TROUBLE OPERATION

A. When a trouble condition is detected by one of the system initiating circuits, indicating circuits, signaling line circuits or auxiliary power supplies, the following shall immediately occur:
   1. The SYSTEM TROUBLE LED shall illuminate steady.
   2. A local sounding device located in the panel shall be activated. The trouble LED for the corresponding initiating, indicating or auxiliary power supply circuit shall light on its respective module.
   3. The condition shall be enunciated by the 80 character alpha-numeric LCD display located on the panel. In addition, the trouble will be displayed on any serial remote LCD display/control unit.
   4. The trouble condition shall be reported to the central station connection via digital communicator.
   5. Upon restoration of the condition that caused the trouble indication, the system shall automatically return to display of time and date, thus indicating the return to normal operating conditions.

4.3 SYSTEM ALARM OPERATION

A. The operation of a manual station or activation of any smoke detector, duct smoke detector, heat detector, sprinkler water flow switch or other automatic alarm initiating device shall cause all of the following to immediately occur:
   1. The SYSTEM ALARM LED shall illuminate steady.
   2. All audible indicating devices throughout the building shall be activated.
   3. All visual indicating devices throughout the building shall be activated. Visual indicating devices shall be so connected that the silencing of the audible signals will not also silence the visuals. Visual indicating devices and circuits shall not be silenced unless reset from the panel.
   4. A local sounding device located in the panel shall be activated.
   5. The corresponding red alarm LED will light on the appropriate initiating zone module or addressable analog loop module.
   6. The alarm condition shall be annunciated by the 80 character alpha-numeric LCD display located on the panel, and at all serial remote LCD display/control units.
   7. The alarm condition shall be reported to the central station via digital communicator.
   8. All other automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays activated.

4.4 SUPERVISORY OPERATION

A. Any initiating device circuit of the system shall be programmable to provide supervisory operation. Activation of a circuit so programmed will cause the yellow LED on the associated module to illuminate, the local audible device to sound and cause the 32 character LCD display to show the condition and location of such activation. Restoration of the supervisory device to its normal state shall cause the module to automatically return to normal standby condition.

4.5 FIELD PROGRAMMING

A. The system shall be fully programmable, configurable, and expandable in the field without the need for special tools or PROM programmers and shall not require replacement of memory ICs. All programming may be accomplished through the front control panel switches and indicators or optionally via laptop computer. All programs shall be stored in non-volatile memory. Entry into the panel programming mode shall be password protected and there shall be two (2) levels of access to programming mode. Any indicating circuit or control relay may be programmed to activate on alarm of a single initiating zone or any combination of initiating zones. It shall be possible to program each zone input individually for:

Alarm verification
Zone code (PNISP)
Water flow operation
Supervisory operation with off normal restoration

B. It shall be possible to program each signaling or relay circuit individually for:

Steady output
Temporal code
Coded (Zone - PNISP, Master)
March time code
Adjustable delay on (0 - 255 seconds)
Adjustable delay off (0 - 255 minutes)
Operation from any zone or combination of zones

PART 5 - EXECUTION

5.1 FIRE ALARM / LIFE SAFETY SYSTEM INSTALLATION

A. Installation of the fire alarm / life safety system shall be in strict compliance with manufacturer's recommendations, local, state and national codes. Consult the manufacturers control panel and peripheral equipment installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation.

5.2 CABLE AND WIRING

A. The fire alarm / life safety installation shall comply fully with all local, state and national codes, and the Local Authority Having Jurisdiction (AHJ). The fire alarm control panel shall be connected to a separate dedicated branch circuit. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Cable shall be FPLR type listed for fire alarm/ life safety use and shall be installed per NEC Article 760.

5.2 FINAL SYSTEM ACCEPTANCE

A. The system shall be accepted only after a satisfactory test of the entire system has been accomplished by a factory trained distributor in the presence of a representative of the Authority Having Jurisdiction and the owner's representative.

5.3 ON-SITE SERVICES

A. The distributor shall provide the on-site services of an authorized, factory trained technical representative to supervise all connections and fully test all devices and components of the system during installation phase. The distributor shall provide comprehensive training on the operation, proper use and testing of the installed fire alarm system to the building owner's representative and the local AHJ.

END OF SECTION 28 31 00

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. This work consists of clearing, grubbing, removing, and disposing of all debris and of all vegetation.
2. Removal of buildings and foundations not removed by others that are within designated construction areas, except for such objects that the Owner or Owner's Representative designates to remain.
3. The work shall also include preserving and protecting from injury or defacement all vegetation and objects designated to remain.
4. Topsoil excavation is not included.

B. Related Sections:

1. Section 310000 – Earthwork
2. Section 312500 – Erosion and Sedimentation Controls
3. Section 329219 – Seeding

1.3 DEFINITIONS

A. Not Used.

1.4 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

1.5 QUALITY ASSURANCE

A. Perform work in compliance with applicable requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Contractor shall obtain all necessary permits from regulatory agencies including signing and resubmitting Notices of Intent (NOI) and Stormwater Pollution Prevention Plans (SWPPP).

B. Obtain any other necessary permits required to perform this work.

PART 2 - PRODUCTS

B. Not Used.

PART 3 - EXECUTION

3.1 PROTECTION

A. The Owner or Owner's Representative will designate all trees, shrubs, plants, and other items within the project area that are to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be an asphaltum base paint prepared especially for tree surgery and approved by the Engineer.

B. Preserve from injury all trees and other vegetation that are not within designated areas of clearing and grubbing, unless marked for removal by the Owner or Owner's Representative.

3.2 CLEARING

A. The project area shall be cleared of all dead trees, stumps, brush, hedges, weeds, logs and other objectionable material and vegetation. Remove tree stumps, boulders, and obstructions to a depth of 2 feet below subgrade. Scarify rock to a depth of 1 foot below subgrade.

B. In areas where excavation is to be made and 5 feet beyond the excavation limits, all trees, stumps, roots, brush, hedge, heavy growth of vegetation, etc., shall be cleared and grubbed.

C. In areas where embankments are to be constructed, all trees, stumps, roots, brush, hedge, heavy growth of vegetation, etc., shall be cleared and grubbed to a point 5 feet beyond slope intercepts. All depressions made below the ground surface shall be refilled with suitable material and compacted before the embankment is started. Unsatisfactory material such as brush, hedge, roots, stump, branches and logs of trees, heavy vegetation, etc. shall not be embedded or buried within the embankment.

D. All slopes of cuts, embankments, ditches, channels, waterways and all structures, both old and new, shall be cleared and cleaned of all brush, hedges, weeds, heavy vegetation, obstruction, rubbish and other objectionable material or growth; and shall be maintained in a neat, serviceable and satisfactory condition until the project is accepted.

E. Borrow pits and other material pits shall be cleared and grubbed of all trees, stumps, roots, brush, hedge, and other heavy growths of vegetation, and in addition shall be stripped of overburden laying above the material to be obtained. This work is to be completed before any excavation is made in the pit area.

F. All clearing and grubbing shall be completed a satisfactory distance ahead of the construction operations before construction stakes are set.

3.3 CLEANUP AND PROTECTION

A. Unless otherwise approved by the Owner or Owner's Representative, all materials and debris from the clearing and grubbing operation shall be burned, completely destroyed, or otherwise disposed of from the project limits by the Contractor in a satisfactory manner.

B. The Contractor must obtain written permission from any property owner if private property is used for disposal, and furnish a copy to the Engineer. All Federal, State, local laws, regulations and ordinances related to burning or disposal shall be observed. If on-site disposal is approved by the Owner, coordinate the exact location of disposal with the Owner.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Excavation, placing, and spreading of topsoil.
5. Excavation and grading of roadways, borrow pits, waterways, ditches, and other specified items, within the project limits.
6. Excavation of unsuitable material beneath embankment areas.
7. Excavating select material for specific use in the construction; trimming, shaping and dressing of all slopes; preparation of the subgrade for building slabs, walks, and pavements.
8. Disposing of all excavated materials. Constructing of embankments and the placing and compacting of approved material in the project area, finish grading.

B. Related Sections:

1. Section 311000 – Site Clearing
2. Section 312333 – Trenching and Backfilling
3. Section 312500 – Erosion and Sedimentation Control
4. Section 329219 - Seeding

1.3 DEFINITIONS

A. Backfill: Soil, aggregate, or controlled low-strength material used to fill an excavation.

B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

C. Excavation: Removal of material encountered above subgrade elevations and to the lines, grades, elevations, and dimensions indicated on the Plans. Excavation shall also consist of the legal and appropriate disposal of unsatisfactory materials. THE CLASSIFICATION OF EXCAVATION WORK MUST BE DEFINED AND APPROVED BY THE OWNER OR OWNER'S REPRESENTATIVE PRIOR TO BIDDING, PRICING, AND BEGINNING WORK.

D. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

1. Borrow Excavation: Consists of material required for the construction of embankments or other portions of the work, and shall be obtained from the approved sources outside project limits, unless otherwise designated in the Plans. This item shall consist of the satisfactory removal and placement of the approved material, outside that required to complete the work contained in the Contract Documents.
2. Common Excavation: Excavation as described above including slabs or fragments of rock of less than 1/2 cubic yard in volume and all other material not otherwise classified in these specifications. Common Excavation does not include the stripping, stockpiling and placing of topsoil.
3. Mass Rock Excavation: Consists of the removal and satisfactory disposal of non-degradable rock which, in place, rings under the hammer or which cannot be economically excavated by the proper use of a power shovel or without the use of explosives; and any boulder, slab or fragment of rock having a volume of 1/2 cubic yard or more.
4. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at no additional cost to the Owner.
5. Unclassified Excavation: Without regard to the materials encountered, all general excavation shall be unclassified. It shall be distinctly understood that any reference to rock, earth, or any other material on the Plans is not to be taken as an indication of classified excavation or the quantity of rock, earth, or any other material involved. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made. No allowance or extra payments will be made by reason of variation in types of soil encountered or variations in moisture contents. Additional fill material required shall be furnished and included as a part of the work. The bidders must draw their own conclusions as to the conditions to be encountered.

E. Fill: Satisfactory materials used to raise existing grades.

F. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 1/2 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

G. Satisfactory Materials or Structural Soil Fill: ASTM D 2487 soil classification groups GW, GP, SW, SP, SM, ML, CL, CH, and SC or a combination of these group symbols and also include:

1. Soil materials that are clean, free or organics, debris, waste, frozen materials, vegetation and other deleterious material, containing no rock fragments or gravel larger than 4 inches in any dimension.
2. Soil material with a standard Proctor maximum dry density of 90 pounds per cubic foot (pcf) or greater, a plasticity index (PI) of 35 percent or less, and a liquid limit (LL) of 55 percent or less.
3. All material to be used as structural fill should be tested by the geotechnical engineer to confirm that it meets the project requirements before being placed.

H. 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.

I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

J. Undercutting: Removal and disposal of unsatisfactory material excavated below the subgrade in cut sections from areas which embankments are to be placed. The quantity of undercut material shall be quantified by the Geotechnical Engineer. Undercut areas shall be backfilled with satisfactory material.

K. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory and include:

1. Man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory materials which contains root and other organic matter or frozen material. The ITL shall be notified of any contaminated materials.
2. Soils that are too soft, expansive soils having a plasticity index and a liquid limit not consistent with the requirements of satisfactory soils as defined herein.
3. Soils classified as PT, OH, and OL.

L. Topsoil: Natural, fertile, friable soil possessing characteristics of representative productive soils in the vicinity; obtained from naturally well-drained areas; shall not be excessively acid or alkaline nor contain toxic substances that may be harmful to plant growth. Topsoil shall be without admixture of subsoil and shall be cleaned and reasonably free from clay lumps, stones, stumps, roots, or similar substances 2 inches or more in diameter, debris, or other objects that are a hindrance to planting operations. Topsoil may include soils that have been stripped from the site and that have been stockpiled as specified elsewhere. If the quantity of topsoil on the job is inadequate, furnish enough additional topsoil to meet the requirements of the project specifications.

M. Wet Soils: Soils that are too wet to use as backfill in their current state, but that meet the requirements of satisfactory soils. These soils are considered to be satisfactory soils. The Contractor shall be responsible to employ either mechanical or chemical methods to dry on-site soils so that the specified compaction can be achieved.

1.4 SUBMITTALS

A. Submittals shall be in pdf format electronic form (e.g, via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Report the results of all density tests to the Owner or Owner's Representative. Include location of test, date of test, note of re-test, test location, depth below finished grade, wet density, moisture content, dry density, percent compaction of test sample, maximum dry density used for comparison, and any other information specified.

C. Provide as-built elevations of building subgrades and top of stone prior to pouring foundations or pads.

1.5 QUALITY ASSURANCE

A. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing shall be the responsibility of either the Contractor or the Owner. DO NOT BID, PRICE, OR BEGIN WORK on this project until the ownership of this responsibility has been adequately identified and agreed upon by both parties. Do not assume that the Contractor will provide these services. Notify the Engineer once an arrangement has been made.

C. Testing shall be performed by a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection services for quality control testing during earthwork operations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of materials shall be in accordance with the Contract Documents and the local, State, and Federal requirements.

B. Transport off site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

1.7 FIELD CONDITIONS

A. If available, data in subsurface investigation reports used for the basis of the design and are available to Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.

B. Additional test borings and other exploratory operations may be performed by Contractor, at Contractor's option. However, no change in the contract price will be authorized for such additional exploration.

C. Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active. Repair damaged utilities to satisfaction of utility owner.

D. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

E. Contractor shall obtain all necessary permits from regulatory agencies including signing and resubmitting Notices of Intent (NOI) and Stormwater Pollution Prevention Plans (SWPPP).

F. Do not bring explosives onto site or use in work without prior written permission from the Owner, Engineer, and authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted. Provide a pre-blast survey before beginning work.

G. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required by authorities having jurisdiction.

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

I. Perform excavation by hand within drip-line of large trees to remain. Protect root systems from damage or dry-out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

J. Protect improvements on adjoining properties and on the Owner's property. Do not disturb any improvements outside the work area defined on the Plans. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL AND ROCK MATERIALS

A. Fill and Backfill: Excavated and re-used material for subsoil fill as defined herein and as considered satisfactory soils.

B. Imported or Borrow Fill Material: Satisfactory material that is provided from off-site borrow areas when sufficient satisfactory materials are not available from required excavations. Locations for imported or borrow material shall be approved by Owner.

C. Dense Graded Aggregate Fill and Backfill: Dense graded aggregate used as fill below the building or pavement subgrade areas, particularly in areas where soft soil conditions are encountered and undercut near subgrade level. Crushed stone fill should be Type A, Class A, and Grading E in accordance with Section 903.05 of the Tennessee Department of Transportation specifications.

D. Topsoil as specified herein.

PART 3 - EXECUTION

3.1 PREPARATION

A. Identify required lines, levels, contours, datum, elevations, and grades necessary for construction as shown on the Plans.

B. Complete all necessary clearing and grubbing, removal of structures and obstructions, and installation of erosion and sediment controls prior to beginning excavations.

C. Notify utility companies to remove or relocate public utilities that are in conflict with proposed improvements. Pothole utilities to confirm that there will be no interferences or reduction in cover beyond the required minimum.

D. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs, unless otherwise noted on the drawings from excavating equipment and vehicular traffic.

E. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

F. Excavation within the limits of the project shall be performed to the lines and grades as indicated on the Plans. Excavations carried below the depths indicated, without specific directions, shall, except as otherwise specified, be refilled to the proper grade with satisfactory material as directed by the Engineer.

3.2 DEWATERING

A. Provide dewatering systems as required for excavations, in general this includes:

1. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a

manner, termed as a "quick" or "boiling" condition. System shall not be dependent solely upon sumps or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation's stability.

2. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow Work to be installed in a dry condition.
3. Control, by acceptable means, all water regardless of source. Contractor shall be responsible for disposal of the water.
4. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary, lower water level in advance of excavation utilizing wells, wellpoints, jet educators, or similar positive methods. The water level as measured by piezometers shall be maintained a minimum of 3 feet below prevailing excavation level.
5. Commence dewatering prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
6. Open pumping with sumps and ditches will be allowed provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
7. Install wells or wellpoints, if required, with suitable screens and filters so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner. During normal pumping and upon development of wells, levels of fine sand or silt in the discharge water shall not exceed 5 ppm. Install sand tester on discharge of each pump during testing to verify that levels are not exceeded.
8. Control grading around excavations to prevent surface water from flowing into excavation areas.
9. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head.

B. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work. Contractor shall be responsible for the accuracy of the Plans, design data, and operational records required. Contractor shall be responsible for the design, installation, operation, maintenance, and failure of any component of the system.

C. Contractor shall be responsible for and shall repair any damage to work in place, other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation. Contractor responsibility shall also include, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

D. Remove subgrade materials rendered unsatisfactory by excessive wetting and replace with approved backfill material at no additional cost to the Owner.

E. Maintaining Excavation in Dewatering Condition:

1. Dewatering shall be a continuous operation. Interruptions due to power outages or any other reason will not be permitted.
2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner.
4. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components and any other work required to maintain excavation in dewatered condition.

F. Upon completion of the work, remove dewatering equipment from the site, including related temporary electrical service.

G. Wells shall be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

3.3 TOPSOIL EXCAVATION

A. Strip topsoil within the limits of excavation to full depth or to a minimum depth of 6-inches. Stripping operations should extend a minimum of 5 feet beyond the limits of proposed pavement areas and 10 feet beyond building limits.

B. Temporarily stockpile topsoil in storage piles. Confirm the location of the storage areas with the Owner. Construct storage piles to freely drain surface water. Cover storage piles as required to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by Owner. Remove excess topsoil from site unless specifically noted otherwise on the Plans.

3.4 GENERAL EXCAVATION

A. When performing grading operations during periods of wet weather, provide adequate dewatering, drainage and ground water management to control moisture of soils.

B. Excavate to the line and grade as shown on the Plans being careful not to over excavate beyond elevations needed for building subgrades.

C. Perform excavation using capable, well-maintained equipment and methods acceptable to Owner and local governing agencies.

D. Remove from site, material encountered in grading operations that, in opinion of the Engineer is unsatisfactory material or undesirable for backfilling, subgrade, or foundation purposes. Dispose of in manner satisfactory to the Owner and local governing agencies. Backfill areas with layers of satisfactory material and compact as specified herein.

E. Unsatisfactory excavated material shall be disposed of in manner and location that is acceptable to Owner and local governing agencies.

F. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction including OSHA (29 CFR Part 1926) excavation trench safety standards. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

G. Shore and brace excavations where sloping is not possible either because of space restrictions or stability of material excavated. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Shoring and bracing design, installation, maintenance, and removal are the sole responsibility of the Contractor. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

H. A professional engineer that is licensed in the area where the work is being performed shall design the sheeting, shoring, and bracing system. However, the contractor is solely responsible for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of the system.

I. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

3.5 SUBGRADE PREPARATION

A. Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of 8 inches and compacted as specified hereinafter. Extend proofrolling operations a minimum of 10 feet beyond proposed building lines.

B. Subgrades shall be proofrolled to detect areas of insufficient compaction and soft pocket, or areas of excess yielding. Proof-rolling shall be accomplished by making minimum of 2 complete passes with fully loaded tandem axle dump truck with a minimum weight of 20 tons, or approved equal, in each of 2 perpendicular directions while under the supervision and direction of the Geotechnical Engineer. Limit vehicle speed to 3 mph. Areas of failure such as soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as

determined by the Geotechnical Engineer, shall be excavated and re-compacted as specified herein. Continual failure areas shall be stabilized in accordance with the requirements of the Geotechnical Engineer and at no additional cost to Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

C. Subgrade exposed longer than 48 hours or on which precipitation has occurred shall be re-proofrolled. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities at no additional cost to the owner.

3.6 BACKFILLING

A. Fill areas to contours and elevations shown on the Plans with satisfactory materials.

B. Unless otherwise specified for rock fill, rock or stone less than 6-inches in largest dimension may be used in fill below structures, paving, and graded areas, up to 24 inches below surface of proposed subgrade or finish grade of graded areas when mixed with satisfactory material. Rock or stone less than 2 inches in largest dimension may be used in fill within the upper 24 inches of proposed subgrade or finish grade of graded areas when mixed with satisfactory material.

C. Place backfill 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.

D. Do not place backfill on surfaces that are muddy, frozen, or contain frost or ice.

E. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

3.7 COMPACTION

A. In excavated areas, scarify the upper 6 to 10 inches of the subgrade and compact.

B. Compact each lift of structural soil fill or dense graded aggregate to at least 98 percent of the soil's maximum dry density per the standard Proctor method (ASTM D 698) and within the range of minus (-) 2 percent to plus (+) 2 percent of the optimum moisture content.

C. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

D. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

E. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.

F. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing, or pulverizing, until moisture content is maintained to within the specified range of optimum.

3.8 MAINTENANCE OF SUBGRADE

A. Verify finished subgrades to ensure proper elevation and conditions for construction above subgrade.

B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment.

C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material equal to or better than that specified on the Plans. Surface of subgrade after compaction shall be firm, uniform, smooth, stable, and true to grade and cross section.

D. Construct temporary ditches and perform such grading as necessary to maintain positive drainage away from subgrade at all times.

E. Construction traffic patterns should be varied to prevent the degradation of previously stable subgrade.

3.9 FINISH GRADING

A. Do not begin work until the earth is dry enough to be tillable. Inspect subgrades to see that they generally conform to the elevations, slopes, and standards as specified on the Plans and within these specifications, particularly with regard to the approximate depths required for the work. After work is completed, inspect it to ensure that the finish grading complies with the design requirements and Plans.

B. Subgrades shall be graded to within not more than 0.10′ above or below the required elevations.

C. Grassed or finish areas to receive topsoil shall be graded to within not more than 0.10' above or below the required elevations.

D. Shape surface of areas under pavement and sidewalks to line, grade, and cross-section, with finish surface not more than 0.04' above or below the required subgrade elevation.

E. Grade surface of fill under building slab smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 0.04′ above or below the required final elevation.

3.10 PLACING AND SPREADING TOPSOIL

A. Place topsoil uniformly over disturbed areas that do not receive other work. Obtain approval of the finish grading from the Engineer before starting to place topsoil.

B. Scarify subgrade to a depth of 3 inches and place the topsoil to a depth of 6 inches when lightly rolled or, on rock, to a depth of 12 inches.

C. Level the topsoil so that it slopes uniformly and has no water pockets. Carefully rake the topsoil by hand to remove all clods, roots, sticks, stones over 1 inch in diameter, and other foreign materials from the surface. Dispose of excess excavated materials and debris away from the site.

3.11 FIELD QUALITY CONTROL

A. The Geotechnical Engineer shall test each lift of backfill to confirm that the contractors' compaction method is capable of achieving the project requirements before placing any subsequent lifts. Field density tests will be made with a minimum of one test for every 10,000 sq. ft. per lift and for every 5,000 sq. ft. per lift in building areas.

B. The Contractor shall furnish a portion of the job office building at the site for the field technician in charge of making field density determinations. Both electrical current and water shall be provided by the Contractor at or near this designated area for the technician's use.

C. Insufficiently compacted areas shall be scarified and loosened to the full depth of fill or otherwise reworked as necessary to re-compact to the specified density.

3.12 DISPOSAL, PROTECTION, AND CLEANUP

A. Protect newly graded areas from traffic and erosion, and keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. The Contractor is responsible for the stability of all embankments and cut slopes until final acceptance.

C. Where subsequent construction operations or adverse weather disturbs completed compacted areas, scarify surface, re-shape, and compact to required density prior to further construction.

D. Remove waste materials, including unacceptable excavated material, trash and debris, from the Owner's property and legally dispose of it.

END OF SECTION 31 20 00

SECTION 31 23 33 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. Excavation of trenches for installation of utilities.
2. Backfilling trenches with bedding material as specified and filling trenches with suitable material to proposed subgrade.
3. Compacting backfill materials in acceptable manner.
4. Borings and casings under roads.

B. Related Sections:

1. Section 311000 – Site Clearing
2. Section 312000 – Earthwork
3. Section 312500 – Erosion and Sedimentation Control
4. Section 329219 – Seeding
5. Section 331100 – Water Lines
6. Section 333100 – Sanitary Sewer (Gravity)
7. Section 333400 – Sanitary Sewer (Force Mains)
8. Section 334000 – Storm Sewer

1.3 DEFINITIONS

A. Backfill or Fill: Refer to Section 312000 – Earthwork for definitions of satisfactory soils, structural soil fill, and unsatisfactory soils.

B. Base Rock: Granular material upon which manhole bases and other structures are placed.

C. Bedding Material: Class B granular material upon which pipes, conduits, cables, or duct banks are placed.

D. Borrow or Imported Material: Suitable structural backfill material obtained by Contractor from source(s) offsite. Refer to Section 312000 – Earthwork.

E. Excavation Classifications: The classification of TRENCH excavation work IS

CONSIDERED UNCLASSIFIED unless defined otherwise by the Owner prior to bidding, pricing, and beginning work. Refer to Section 312000 – Earthwork for excavation classifications.

F. Lift: Loose (uncompacted) layer of material.

G. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

H. Trench: The word "trench" shall mean excavations having vertical sides whose depths exceed its width, made for storm water drainage, sanitary sewer, water, gas pipes, electric power or lighting, communications, steam conduits, and related uses.

I. Trench Excavation (unclassified) shall consist of the removal of all materials necessary for the construction of storm sewers, culvert pipes, other pipe lines and all drainage structures such as manholes, catch basins, junction boxes, head walls, wing walls and concrete collars.

1.4 SUBMITTALS

A. Submittals shall be in pdf format electronic form (e.g, via email) and shall be stamped by the Contractor. Do not submit un-stamped shop drawings. Submit to the Owner or Owner's representative.

B. Report the results of all density tests to the Owner or Owner's Representative. Include location of test, date of test, note of re-test, test location, depth below finished grade, wet density, moisture content, dry density, percent compaction of test sample, maximum dry density used for comparison, and any other information specified.

1.5 QUALITY ASSURANCE

A. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a Registered Land Surveyor and replaced, as necessary, by same.

B. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

C. Trench design and safety for pipe and conduit construction is solely the responsibility of the contractor and shall conform to all applicable local, state, and OSHA regulations.

D. Accurately record actual locations of subsurface utilities, structures, and obstructions installed or encountered.

E. Testing shall be the responsibility of either the Contractor or the Owner. Do not bid, price, or begin work on this project until the ownership of this responsibility has been adequately identified and agreed upon by both parties.

F. Testing shall be performed by a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection services for quality control testing during earthwork operations.

G. Do not bring explosives onto site or use in work without prior written permission from the Owner, Engineer, and authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted. Provide a pre-blast survey before beginning work.

H. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required by authorities having jurisdiction.

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

J. Perform excavation by hand within drip-line of large trees to remain. Protect root systems from damage or dry-out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

K. Protect improvements on adjoining properties and on the Owner's property. Do not disturb any improvements outside the work area defined on the Plans. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of materials shall be in accordance with the Contract Documents and the local, State, and Federal requirements.

1.7 PROJECT CONDITIONS

A. If available, data in subsurface investigation reports used for the basis of the design are available to Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.

B. Additional test borings and other exploratory operations may be performed by Contractor, at Contractor's option. However, no change in the contract price will be authorized for such additional exploration.

C. Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active. Repair damaged utilities to satisfaction of utility owner.

D. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

E. Contractor shall obtain all necessary permits from regulatory agencies including signing and resubmitting Notices of Intent (NOI) and Stormwater Pollution Prevention Plans (SWPPP).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bedding Material (Class B): Bedding material shall be compacted granular material consisting of well-graded crushed stone or crushed gravel meeting the requirements of TDOT (latest edition), Section 903, Grading Size No. 57 or No. 67.

B. Backfill Material (Open Areas): Material excavated from trenches or from other on-site sources or borrow (i.e., imported) material from off-site and as defined in Section 312000 – Earthwork as satisfactory soils. Backfill material shall not contain rock or stone with a maximum size greater than 2 inches.

C. Backfill Material (Paved Areas): Backfill material for pipe under pavement or less than 5 feet from the outside edge of the pavement shall be as specified on the Plans. Based on the reviewing jurisdiction, backfill material shall be either:

1. Mineral aggregate base crushed stone meeting the requirements of TDOT (latest edition), Subsection 903.05, Class A aggregate Grading D.
2. Well-graded crushed stone or crushed gravel meeting the requirements of TDOT (latest edition), Section 903, Grading Size No. 57 or No. 67.

D. Steel Casing Pipe: Comply with AWWA C200 minimum grade B, size, and wall thickness as indicated on Construction Plans.

E. Topsoil: Topsoil as defined in Section 312000 – Earthwork.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; 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.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) 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 (750 mm) 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. Prior to the beginning of grading, all necessary clearing and grubbing, removal of structures and obstructions, and placement of erosion and sediment controls in that area shall have been completed.

B. Contact local utility companies before excavation begins.

C. Maintain in operating condition existing utilities, previously installed utilities, and drainage systems encountered in trenching excavation.

D. Verify location, size, elevation, depth (by potholing or other approved methods), and other pertinent data required to make connections or to avoid interfering with existing utilities and drainage systems.

E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

F. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

G. Perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Engineer deems necessary to maintain vehicular or pedestrian traffic.

H. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

I. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 EXCAVATION FOR TRENCHES

A. Excavation within the limits of the project shall be performed to the lines and grades as indicated on the Plans. Excavations carried below the depths indicated, without specific directions, shall, except as otherwise specified, be refilled to the proper grade with satisfactory material as directed by the Engineer.

B. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel type trenching machines are used, do not use clods for backfill.

C. Trench design and safety is solely the responsibility of the contractor. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Unless regulated otherwise, lateral travel distance to exit ladder or steps shall not be greater than 25-feet in trenches 4-feet or deeper. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

D. Unless the construction of lines by tunneling, jacking, or boring is called for by the Plans or specifically authorized by the Engineer, make excavation for pipelines in open cut and true to the lines and grades shown on the Plans or established by the Engineer on the ground. Any cut made in excess of the minimum trench width, formula outside diameter 4/3 O.D. + 15″ or the typical trench dimensions as shown on the Plans shall be at the expense of the Contractor and may be cause for the Engineer to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

E. Locate and retain soil materials away from edge of excavations. In all cases where materials are deposited along open trenches, place them so that in the event of rain or surcharge loading from such deposits, no damage will result to the work and/or to adjacent property. Do not store within drip line of trees indicated to remain.

F. Pipe trenches shall not be excavated more than 400 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

G. For work within public right-of-ways and during working hours, the maximum amount of exposed pipe trench shall be 50 feet of pipe or two pipe joints, whichever is shorter. During nonworking hours, use one of the following methods of trench protection:

1. Steel plate, minimum 5/8 inch thick, over entire trench or excavation overlapping each pavement edge by 1 foot minimum.
2. Concrete barriers placed around entire trench or excavation.

3. Backfill and compact entire trench or excavation.
4. Cones, barrels, and illumination manned by flagmen.

H. Trench Bottoms: Accurately excavate and shape trench bottoms to designated elevations, to provide uniform bearing and support for each section of pipe once bedding material is installed at every point along entire length, except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections.

1. For pipes 15 inches and smaller, excavate the bottom of the trench 4 inches below the bottom of pipe that is to be installed;
2. For pipes 18 inches to 36 inches, excavate the bottom of the trench 6 inches below the bottom of pipe that is to be installed;
3. For pipes 42 inches and larger, excavate the bottom of the trench 8 inches below the bottom of pipe that is to be installed;
4. Where rock or other unyielding bearing material is encountered, excavate trenches 6 inches below required elevation and backfill with a 6-in. layer of TDOT no. 57 or No. 67 crushed stone prior to installation of pipe bedding;
5. For bell and spigot pipe, excavate bell holes at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than 2 joints ahead of pipe laying;
6. If wet or unstable soil is encountered, over excavate from trench bottom as necessary to provide suitable base for continuous and uniform bedding;
7. Remove projecting stones and sharp objects along trench subgrade.

I. Excavation for manholes, inlets, and other incidental structures may be performed with non-vertical banks except beneath pavements or adjoining existing improvements and shall not be greater in horizontal area than that required to allow a 2 foot clearance between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the Plans. No earth backfilling will be permitted under manholes, inlets, headwalls, or similar structures. Should the Contractor excavate below the elevations shown or specified, he shall, at his own expense, fill the void with either concrete or granular material approved by the Engineer.

J. Remove excavated materials not required or not suitable for backfill or embankments and legally waste off-site or on-site at Owner approved locations. Provide other suitable material at no additional cost to Owner.

3.3 SHEETING, SHORING, AND BRACING

A. Where sloping is not possible either because of space restrictions or stability of material excavated, sufficiently sheet, shore, and brace the sides of excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep

the walls of the excavation properly in place, and to protect all persons and property from injury or damage.

B. A Professional Engineer shall design the sheeting, shoring, and bracing system. However, the contractor is solely responsible for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of the system. Sheeting, shoring, and bracing shall conform to all applicable local, state, and OSHA regulations. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

C. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures in substantial compliance with Plans sealed by a Professional Engineer wherever necessary. Notify adjacent property owner of the excavation.

D. Sheeting, shoring, or bracing materials shall not be left in place unless this is called for by the Plans, ordered by the Engineer, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.

E. All holes and voids that remain due to the removal of sheeting, shoring, or bracing shall be filled and compacted as specified herein.

F. A trench box may be used, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

3.4 DEWATERING OF EXCAVATION

A. Prevent surface water and subsurface or groundwater from flowing into excavations and re-route surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

B. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other de-watering system components necessary to convey water away from excavations.

C. Provide and keep in operation enough suitable pumping equipment whenever necessary. Give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift. Dewatering shall occur only in accordance with applicable Laws and Regulations, approved permits, and industry best management practices.

3.5 PIPE BEDDING

A. Bedding shall be installed by placing bedding material from the trench bottom, for the entire trench width, up to the bottom of the pipe. The middle of the bedding, under the pipe invert, equal to 1/3 of the pipe O.D. should be loosely placed and accurately shaped to conform to the lower portion of the pipe barrel, with the remainder compacted to minimum standard proctor density. Backfill the haunches of the pipe in loose lifts not exceeding 6-inches and compact. Continue backfilling and compacting each lift vertically up to the spring line of the pipe.

B. Do not place bedding material over porous, wet, frozen, or spongy subgrade surfaces.

3.6 BACKFILL AND FILL

A. Do not backfill trenches until the pipe has been laid to line and grade and properly bedded, tests and inspections have been made, utility systems comply with and are accepted by applicable governing authorities, and backfilling is authorized by the Owner. Use care in backfilling to avoid damage or displacement of pipe or conduit systems.

B. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces. Backfill evenly and simultaneously on both sides of the pipe up to the subgrade elevation.

C. Under unpaved areas (i.e., open areas), backfill the trench as follows:

1. For flexible pipe in unpaved areas, the initial backfill above the spring line shall be granular material as specified in Section 2.1 Materials. Place in loose lifts not exceeding 6-inches, compact, and extend to 12-inches above the top of the pipe. The final backfill shall be suitable excavated or borrow (i.e., imported) material as specified in Section 2.1 Materials. Place material in loose lifts not exceeding 6-inches, compact, and extend to the required subgrade elevation.
2. For rigid (i.e., concrete) pipe in unpaved areas, backfill above the spring line with suitable excavated or borrow (i.e., imported) material as specified in Section 2.1 Materials. Place material in loose lifts not exceeding 6-inches, compact, and extend to the required subgrade elevation.

D. Under paved areas, within 5 feet of pavement edge, and within 10 feet of a building pad backfill above the spring line with granular material as specified in Section 2.1 Materials. Place material in loose lifts not exceeding 6-inches, compact, and extend to the required subgrade elevation.

E. Flowable Fill or Controlled Low Strength Material (CLSM): Where indicated on the Plans or as required to expedite trench backfill or to protect pipe, backfill with CLSM or flowable fill above pipe bedding. Do not allow dirt or foreign material to become mixed with concrete during placement. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in the trench. Place in lifts as necessary to prevent uplift (flotation) of new and existing pipes.

F. Concrete: Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and which are carried below the bottom of such footings, or

which pass under wall footings. Place concrete to the level of the bottom of adjacent footing.

G. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

H. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice. Adjust moisture content as necessary to obtain specified compaction.

I. Backfill to the subgrade elevations as determined from the Plans.

3.7 COMPACTION

A. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.

B. Mechanically compact each lift (e.g., vibratory sleds, jumping jacks) prior to placing succeeding lifts. Compaction of the haunch layer may require a small tamping mechanism to obtain the specified compaction in a confined area.

C. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.

D. Maintain moisture content within the specified range of optimum of fill materials as specified in Section 312000 – Earthwork to attain required compaction density.

E. Compact each lift of aggregate backfill to at least 98% of the standard Proctor maximum density (ASTM D 698). In open areas, compact each lift of soil backfill to at least 95% of the standard Proctor maximum density (ASTM D 698).

F. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing, or pulverizing, until moisture content is maintained within the specified range of optimum.

3.8 PLACING AND SPREADING TOPSOIL

A. Place topsoil uniformly over disturbed areas that do not receive other work. Obtain approval of the finish grading from the Owner before starting to place topsoil.

B. Level the topsoil so that it slopes uniformly and has no water pockets. Carefully rake the topsoil by hand to remove all clods, roots, sticks, stones over 1 inch in diameter, and other foreign materials from the surface. Dispose of excess excavated materials and debris away from the site.

3.9 FIELD QUALITY CONTROL

A. Beginning at a depth of 2 feet above the top of the pipe, provide a density test for each lift of compacted fill, at a maximum horizontal spacing of 200 feet, and at all proposed or existing street or pavement crossings. If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests.

B. The Contractor shall furnish a portion of the job office building at the site for the field technician in charge of making field density determinations. Both electricity and water shall be provided by the Contractor at or near this designated area for the technician's use.

C. Insufficiently backfilled or compacted areas shall be scarified and loosened to the full depth of fill or otherwise re-worked as necessary to re-compact to the specified density.

3.10 PROTECTION AND CLEANUP

A. Protect newly graded areas from traffic and erosion, and keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Where subsequent construction operations or adverse weather disturbs completed compacted areas, scarify surface, re-shape, and compact to required density prior to further construction.

C. Remove waste materials, including unacceptable excavated material, trash and debris, from the Owner's property and legally dispose of it.

END OF SECTION 31 23 33

SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Tennessee Erosion and Sediment Control Handbook (Tennessee Department of Environment and Conservation, latest edition) and the regulations, policies, etc. of the local jurisdiction regarding materials, installation, and maintenance of best management practices for erosion and sedimentation controls.

C. The project Stormwater Pollution Prevention Plan (SWPPP).

1.2 SUMMARY

A. Section includes:

1. Erosion and sediment control for excavation, backfill, and/or other construction activities within the limits of the construction site, within any temporary or permanent easements, and within any borrow site.

2. Work necessary to ensure that construction activities do not temporarily or permanently harm the waters of the State of Tennessee, nor properties of the Owner, nor adjoining owners.

B. Related Sections:

1. Section 311000 – Site Clearing
2. Section 310000 – Earthwork
3. Section 329219 – Seeding

1.3 DEFINITIONS

A. Fines from Regulators: Any fines levied by the Federal, State, and/or local governments for non-conformance with their respective regulations related to erosion and pollution control shall be paid for by the Contractor.

B. Duration of Maintenance: Protect the site throughout the construction period regardless of weather conditions until the time that permanent vegetation is established.

C. Responsibility: These activities are related to the means and methods the Contractor uses to pursue the work and as such cannot be predicted in advance. For this reason, the Contractor is solely responsible for conforming to related local, State, and Federal requirements.

1.4 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Submit shop drawings for material substitutions. Do not submit shop drawings for materials that are consistent with the plans. These submittals will be marked "Not Requested for Review" and returned.

1.5 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

1.6 DELIVERY, STORAGE, & HANDLING

A. Delivery, storage, and handling of materials shall be in accordance with these specifications and the manufacturer's requirements.

1.7 PROJECT CONDITIONS

A. Verify the locations of the existing underground utilities by contacting the utility owners and by potholing in the field.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials for erosion and pollution control shall be in accordance with the Plans and the "Tennessee Erosion and Sediment Control Handbook" (Tennessee Department of Environment and Conservation, latest edition) and the requirements. These include, but are not limited to:

1. Silt Fencing
2. Erosion Control Matting
3. Storm Drain Inlet Protection
4. Rip Rap

5. Straw
6. Temporary and Permanent Seeding

2.2 PHYSICAL CONTROLS

A. Physical controls for erosion and pollution control shall be in accordance with the Plans and the "Tennessee Erosion and Sediment Control Handbook" (Tennessee Department of Environment and Conservation, latest edition) and the requirements. These include, but are not limited to:

1. Sediment Traps / Ponds
2. Diversion Ditches

PART 3 - EXECUTION

3.1 GENERAL

A. The temporary erosion and pollution control provisions shown on the Plans are considered the minimum necessary, with the final design, implementation, and maintenance being the responsibility of the Contractor.

B. The Contractor shall prepare a Stormwater Pollution Prevention Plan (SWPPP) and submit or amend the project Notice of Intent (NOI) to include their project specific activities.

C. Install temporary sediment traps where appropriate. Muddy water collected in sediment traps shall be held until it is at least as clear as the upstream water before it is discharged to surface waters. Discharge through a pipe or lined channel so that the discharge does not cause erosion and sedimentation.

D. Install temporary diversion berms or diversion channels as necessary to divert storm water from running onto the disturbed areas and to divert runoff from disturbed areas to the temporary sediment traps.

E. Apply temporary seeding whenever grading operations are temporarily halted for over 14 days and final grading of exposed surfaces is to be completed within one year. Apply temporary seeding to soil stockpiles.

3.2 FIELD QUALITY CONTROL

A. Maintain erosion and sedimentation controls throughout the life of the project. Replace controls and/or add additional ones as needed to meet the requirements of the local, State, and Federal requirements.

3.3 CLEANUP AND PROTECTION

A. Remove erosion and sedimentation control structures once the site has been permanently stabilized. Properly dispose of these materials off-site.

B. Backfill, topsoil, seed, and straw areas disturbed as a result of the cleanup efforts.

END OF SECTION 31 25 00

SECTION 32 12 16 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Standard specifications of the Tennessee Department of Transportation (TDOT). Even though the weather limitations, construction methods, and materials specifications contained in the TDOT Specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this section, be considered as implied and therefore adhered to. However, the various subsections "Basis for Payment" contained in the TDOT specifications shall not be considered applicable.

1.2 SUMMARY

A. Section includes installation of asphalt paving as follows:

1. Installation of aggregate base.
2. Installation of asphalt pavement.
3. Striping asphalt pavement.

B. Related Sections:

1. Section 310000 – Earthwork
2. Section 321600 – Curbs and Gutters

1.3 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Within 14 working days prior to the scheduled start of asphalt construction, submit the actual design mix to the Owner or Owner's representative for review and approval. Design mix submittal shall follow a format in accordance with the Marshall Method of Mix Design (AASHTO T 245) and as modified by TDOT. This information shall include the information as specified by TDOT and as a minimum the following:

1. Type/name of mix.
2. Gradation analysis.
3. Grade of asphalt cement used and optimum asphalt content in percent.
4. RAP size and gradation.
5. Location of the plant.

6. Mixing and compaction temperatures
7. Direct references to TDOT specifications sections for each material.

C. Submit certification that mix design conforms to specification requirements. Materials certificate shall be signed by materials producer and Contractor, certifying that materials and mix design conform to requirements specified herein.

D. Laboratory reports of compaction tests and proof rolling of soil sub-grade.

E. The Contractor shall certify in writing that asphalt pavement (i.e., base and asphalt courses) was placed in accordance with specification requirements. This certification shall include:

1. Verification of the subgrade, mineral aggregate base, and pavement slopes, elevations, and surface smoothness.
2. Results of the mineral aggregate base density tests, laboratory air void, Marshall stability, and flow results, coring locations, compacted thicknesses, asphalt density, and asphalt extraction and aggregate gradation results.

1.4 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

B. An independent testing laboratory may be selected and paid by the Owner to perform construction testing of in-place asphalt courses for compliance with requirements of materials, thickness, compaction, and surface smoothness. This does not relieve the Contractor of any quality assurance responsibilities.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Asphalt delivery, storage, and handling shall be in accordance with the latest edition of the TDOT specifications.

1.6 PROJECT CONDITIONS

A. Weather limitations for pavement to be properly placed, compacted, and finished shall be in accordance with the latest edition of the TDOT specifications, generally these are:

1. For a compacted thickness of 1.5 in. or less the minimum placement air temperature or surface temperature (whichever is less) shall be: 45° F for unmodified mixes and 55° F for modified mixes. For compacted thicknesses greater than 1.5 in., 40° F for unmodified mixes and 50° F for modified mixes.

2. Do not apply when base is wet, contains excess moisture, during rain, or when frozen.

B. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

1.7 GUARANTEE

A. Contractor shall guarantee in writing, the materials and workmanship for a period of two (2) years, beginning on the date of substantial completion or upon Owner's possession, which ever comes later.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Mineral Aggregate Base: Type A Base, Grading D crushed stone (TDOT Specification Section 303);

B. Bituminous Prime Coats: Emulsified asphalt or Grade AE-P (TDOT Specification Section 402);

C. Tack Coat: Emulsified asphalt, SS-1, SS-1h, CSS-1, CSS-1h, TST-1p, CQS 1h (TDOT Specification Section 403);

D. Bituminous Plant Mix Base (Hot Mix): Grading B or BM as directed by the Engineer (TDOT Specification Section 307);

1. Asphalt Cement: Grading B and BM shall range between 4.2 to 6.2;
2. Asphalt temperature: the mixing temperature for PG 64-22 is 290° F minimum and 350° F maximum. The compaction temperature for PG 64-22 is 280° F minimum and 310° F maximum.
3. For Grading B (307B), the RAP maximum particle size is 1-½ in. For Grading BM (307BM) the RAP maximum particle size is ¾ in. The percent RAP (non-processed) is 0% and 25% (processed) for both mixes.
4. The aggregate fractions shall be sized, graded, and combined in such proportions that the resulting composite blend will be met:

	Total % Passing by Weight	
Sieve Size	*Grading B*	*Grading BM*
2 in.	100	-
1-1/4 in.	95 – 100	-
1 in.	-	-
3/4 in.	70 – 85	85 - 100
5/8 in.	-	-
1/2 in.	-	-
3/8 in.	49 – 72	59 – 79
No. 4	34 – 51	42 – 61
No. 8	23 – 42	29 - 47
No. 30	11 – 22	13 – 27
No. 50	9 – 14	7 – 20
No. 100	4 – 10	4 – 10
No. 200	2.5 – 6.5	0 – 6.5

E. Asphaltic Concrete Surface (Hot Mix): Grading D or E as specified (TDOT Specification Section 411).

1. Asphalt cement content for both mixes shall range between 5.3 to 7.0;
2. Asphalt temperature: the mixing temperature for PG 64-22 is 290° F minimum and 350° F maximum. The compaction temperature for PG 64-22 is 280° F minimum and 310° F maximum.
3. RAP maximum particle size is ½ in. Percent of RAP (non-processed) is 0% for both mixes and percent RAP (processed) for Grade D is 15% (PG64-22, PG67-22) or 10% (PG 70-22, PG 76-22, PG 82-22) and for Grade E is 25%.
4. The aggregate fractions shall be sized, graded, and combined in such proportions that the resulting composite blend will be met:

	Total % Passing by Weight	
Sieve Size	*Grading D*	*Grading E*
3/4 in.	100	100
5/8 in.	100	100
1/2 in.	95 - 100	95 - 100
3/8 in.	80 - 93	80 - 93
No. 4	54 - 76	54 - 76
No. 8	35 - 57	35 - 57
No. 30	17 - 29	17 – 29
No. 50	10 - 18	10 – 18
No. 100	3 - 10	3 – 11
No. 200	0 – 6.5	0 - 8

F. Pavement Marking Paint: White and Yellow (TDOT Specification Section 716);

PART 3 - EXECUTION

3.1 SUBGRADE

A. Before any base material is installed, prepare subgrade in accordance with the requirements of the Earthwork Section. The subgrade shall be constructed to the grades shown on the Plans, with an allowable working tolerance of plus or minus 0.1 ft.

B. Protect and maintain subgrade until placement of the final surface is achieved.

C. Establish grades and set grade stakes to the desired section. In establishing the grades, make due allowances for existing improvements, proper drainage, adjoining property rights, and good appearance.

D. The joint between new and existing pavement shall be true and approximately at right angles to the centerline of the existing pavement. When a base course is compacted, cut back the surface course of the existing pavement a minimum of 1 foot beyond the limit of the joint between the old and new base course. Take special care to ensure good compaction of the new base course at the joint. Apply and compact the surface to conform to the existing pavement so that it will have no surface irregularity.

3.2 AGGREGATE BASE

A. Install a mineral aggregate base of the type specified above in accordance with Section 303 of the TDOT Specifications. The maximum compacted thickness of any one layer shall not exceed 6 inches and the total thickness of the base shall be that indicated on the Plans.

3.3 PRIME COAT SURFACE PREPARATION

A. Uniformly apply a bituminous prime coat of emulsified asphalt or Grade AE-P at a rate of 0.2 to 0.5 gal./s.y. Take care to prevent the bituminous material's splashing on exposed faces of curbs and gutters, walls, walks, trees, etc.; if such splashing does occur, remove it immediately. After the prime coat has been properly cured, apply an asphaltic concrete course to the thickness and width shown on the Plans.

3.4 ASPHALTIC CONCRETE PLACEMENT

A. For all areas of more than 1,000 square yards, spread and strike off the asphalt binder course with a paver. Correct any irregularities in the surface of the pavement course directly behind the paver. Remove excess material forming high spots with a shovel or

lute. Fill indented areas with hot mix, and smooth with a lute or the edge of a shovel being pulled over the surface. Casting of mix over such areas will not be permitted.

B. If it is impractical to use a paver or spread box in areas of 1,000 square yards or less, the asphalt binder course may be spread and finished by hand. Carefully place by hand to avoid segregation of the mix. Broadcasting of the material will not be permitted. Remove any lumps that do not readily break down.

C. Remove over-pavement of asphalt and stone from underneath landscape areas up to the limits that have been specified (refer to the curb detail) in order to provide a solid base for the concrete curb.

D. If the asphaltic concrete surface course is to be placed directly on the mineral aggregate base, place a bituminous prime coat as described above. If, however, the surface course is to be placed on a binder course, then apply a bituminous tack coat of the sort specified above under Materials at a rate of 0.05 to 0.10 gal./s.y. when directed by the Engineer. Take care to prevent the bituminous material's splashing on exposed faces of curbs, gutters, walls, walks, trees, etc.; if such splashing does occur, remove it immediately. After the prime or tack coat has been properly cured, apply the asphaltic concrete to the thickness and width shown on the Plans. Apply the surface course as described above for the binder course.

3.5 ROLLING AND COMPACTION

A. After being spread, mixture shall be compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in workable condition.

B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

C. Breakdown Rolling: Perform breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.

D. Second Rolling: Follow breakdown rolling as soon as possible while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.

3.6 JOINTS

A. Place each asphaltic paving layer as continuous as possible to keep the number of joints to a minimum. Create joints between old and new pavement, between successive days work, and where the mixture has become cold (less than 140 degrees F). Make these joints in such a manner as to create a continuous bond between the old and new pavement construction courses.

B. Offset joint of successive courses by at least 6 inches.

C. Transverse Joints: If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smoothness. If the temperature of the previously placed pavement material drops below 140 degrees F before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just before paving is continued.

D. Longitudinal Joints: Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F, with liquid asphalt just before paving is continued.

3.7 TOLERANCES

A. The finished surface of each asphalt course shall conform to the lines and grades shown on the Plans. No deviations, variations, or irregularities exceeding 1/4 inch in any direction when tested with a 12 foot straightedge will be permitted in the finished work, nor will any depressions that will not drain. Correct all such defects.

B. The top surface of the base and binder courses shall be installed to the line, grade, and cross-section as shown on the Plans with a variance in elevation of no greater than plus or minus 0.10 ft.

C. The top of the surface course shall be installed to the line, grade, and cross-section as shown on the Plans with a variance in elevation of no greater than plus or minus 0.04 ft.

3.8 FIELD QUALITY CONTROL

A. The Contractor is responsible for the quality of construction and materials.

B. Verify that the slope, elevations, and smoothness of the subgrade and mineral aggregate base conform to the requirements of the Plans and the specifications.

C. Perform density tests on Type A mineral aggregate base at a minimum rate of 5 density tests per 90,000 sq. ft. The average density shall be not less than 100% of maximum density determined in accordance with AASHTO T 99, Method D with no individual test less than 97% of maximum density.

D. Laboratory Air Void, Marshall Stability, and Flow: During production, mixture samples shall be taken at least four times for every 2000 tons or 8 hour day and compacted into specimens, using compactive blows (35, 50, or 75) equal to mix design per side with the Marshall hammer as described in AASHTO T 245. Temperature shall be equal to temperature at paving machine with reheating. After compaction, the laboratory air voids of each specimen shall be determined, as well as the Marshall stability and flow.

E. Asphaltic pavement courses shall be randomly cored at minimum rate of 1 core per 20,000 sq. ft of paving, but not less than 3 cores. Asphaltic concrete pavement samples shall be tested for conformance with mix design. Cores shall be cut from areas representative of project. Coring holes shall be immediately filled by the Contractor with full-depth asphaltic concrete.

F. Thickness Test: Measure thickness of each core sample taken. The thickness of the course or the combined courses shall meet or exceed the indicated thickness.

G. Density tests shall be conducted on each core sample taken in accordance with ASTM D1188 or D2726 as applicable. The average density shall not be less than 92% of the mixtures maximum theoretical specific gravity with no individual test less than 87%.

H. Asphalt Extraction and Aggregate Gradation: Asphalt extraction and gradation of extracted aggregate testing shall be performed on a minimum of 2 cores in accordance with AASHTO TP 53 and ASTM D5444 respectively.

I. Areas of deficient paving, including thickness, compaction, smoothness, ponding of water for longer more than 24 hours, and asphalt mixture shall be delineated, removed, and replaced in compliance with the specifications requirements unless corrected otherwise as directed and approved by the Owner or Owner's Representative.

3.9 CLEANING AND PROTECTION

A. Remove any excess debris and trash.

B. Prohibit access of vehicles onto any of the asphaltic courses for vehicles that exceed the design load for the current condition of the pavement.

END OF SECTION 32 12 16

SECTION 32 13 13 – CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Standard specifications of the Tennessee Department of Transportation (TDOT) sections 501, 604, 702, and 905. Even though the weather limitations, construction methods, and materials specifications contained in the TDOT Specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this section, be considered as implied and therefore adhered to. However, the various subsections "Basis for Payment" contained in the TDOT specifications shall not be considered applicable.

C. ACI 301, Specifications for Structural Concrete for Buildings.

1.2 SUMMARY

A. Section includes installation of curbs and gutters as follows:

1. Furnishing all plant, labor, equipment, appliances, and materials and of performing all operations in connection with the construction of concrete pavements, sidewalks, concrete steps, and driveway ramps.

B. Related Sections:

1. Section 310000 – Earthwork
2. Section 321600 – Curbs and Gutters
3. Section 321616 – Asphalt Paving

1.3 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

1.4 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

B. An independent testing laboratory may be selected and paid by the Owner to perform construction testing of in-place asphalt courses for compliance with requirements of materials, thickness, compaction, and surface smoothness. This does not relieve the Contractor of any quality assurance responsibilities.

C. Materials, sampling, and testing shall meet the applicable requirements of the Concrete Sections, ACI, and the latest revision of TDOT Section 501, 604, 702, and 905.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Concrete delivery, storage, and handling shall be in accordance with the latest edition of TDOT specifications.

1.6 PROJECT CONDITIONS

A. Weather limitations for pavement to be properly placed, compacted, and finished shall be in accordance with the latest edition of the TDOT specifications, generally these are:

B. Do not place concrete when the ambient temperature is below 35 degrees F, nor when the concrete is, without special protections, likely to be subject to freezing temperatures before final setting has occurred. The temperature of the concrete when placed shall be not less than 50 degrees F, nor more than 90 degrees F. Heating of the mixing water and/or aggregates will not be permitted until the temperature of the concrete has decreased to 55 degrees F. Heated materials shall be free from ice, snow, and frozen lumps before entering the mixer. Methods and equipment for heating shall be subject to the Owner or Owner's Representative's approval. Provide suitable means for maintaining the concrete at a temperature of at least 40 degrees F for not less than 72 hours after placement. Any concrete damaged by freezing shall be removed and replaced at the expense of the Contractor.

C. Do not apply when base is wet, contains excess moisture, during rain, or when frozen.

D. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Concrete shall be f'c = 4,000 psi (unless otherwise shown on the Plans), as defined by ACI standards, air entrained. The applicable provisions of ACI 301,

Specifications for Structural Concrete for Buildings, form a part of this specification. Concrete slump shall range from 0 to 3-in.

B. Joint Filler: Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal.

C. Joint Sealants: Conforming to ASTM D1190, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant", Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 245", or Woodmont Products "Chem-Caulk" or approved equal.

PART 3 EXECUTION

3.1 SUBGRADE AND FORMS

A. Provide and operate a template for checking the contour of the subgrade. The template shall rest on the side forms and shall be provided with adjustable rods that project downward to the subgrade at 1 foot intervals. Adjust these rods to the required cross sections of the bottom of the slab when the template is supported at its sides.

B. Forms shall be of metal or wood and subject to approval by the Engineer.

C. Test the subgrade with respect to elevation and density prior to setting forms. Complete the subgrade to the plane of the typical sections shown on the drawings and to the lines and grades established by the drawings. Compact subgrades in accordance with the requirements in the Earthwork section.

D. After preparing the subgrade as described above, set the forms. The subgrade under the forms shall be firm and cut true to grade so that each form section will, when placed, be firmly in contact for its entire length and base width. Stake the form into position so that the top, when tested by a 10 feet straightedge, conforms to the requirements specified for the surface of the concrete and so that the longitudinal axis of the upstanding leg does not vary more than 1/4 inch. Tightly lock form sections together.

E. Finish the subgrade to the exact section of the bottom of the pavement shown on the drawings. Wet the subgrade down far enough in advance of the placing of the concrete to ensure that it is firm and moist. In cold weather, the subgrade shall be entirely free from frost when the concrete is deposited.

F. Leave forms in place at least 24 hours after the concrete has been placed against them. Do not use crowbars or heavy tools against green concrete when removing the forms. Clean the forms well before re-oiling and reuse.

3.2 PLACING

A. Concrete shall be in place within 45 minutes from the time all ingredients are charged in the mixing drum and before the concrete has obtained its initial set. Deposit concrete so that minimum handling will be necessary, and distribute it so that, when consolidated and finished, the slab thickness and surface grade required by the drawings will be obtained at all points. Place concrete rapidly and continuously between expansion joints. Use shovels for any necessary hand spreading. Consolidate the concrete adjacent to forms and joints with forks and spades.

B. Do not place concrete when the ambient temperature is below 35 degrees F, nor when the concrete is, without special protections, likely to be subject to freezing temperatures before final setting has occurred. The temperature of the concrete when placed shall be not less than 50 degrees F, nor more than 90 degrees F. Heating of the mixing water and/or aggregates will not be permitted until the temperature of the concrete has decreased to 55 degrees F. Heated materials shall be free from ice, snow, and frozen lumps before entering the mixer. Methods and equipment for heating shall be subject to the A/E's approval. Provide suitable means for maintaining the concrete at a temperature of at least 40 degrees F for not less than 72 hours after placement. Any concrete damaged by freezing shall be removed and replaced at the expense of the Contractor.

3.3 FINISHING

A. Immediately after placement, properly finish the concrete. The sequence of operations shall be as follows: hand finishing, longitudinal floating, straightedge finishing, and edging the joints.

B. Provide an approved hand strike template, approved tamping template, and a longitudinal float for the hand finishing of pavement. The templates shall be at least 1.0 foot longer than the pavement width and at least 4 inches wide. The longitudinal float shall be 6 feet to 8 feet long. The float shall be rigid and substantially braced and provided with suitable handles to ensure smooth and effective manipulation. The bottom edges of the base of the float shall be rounded. Floats made of metal or a combination of wood and metal may be used.

C. As soon as concrete is placed, strike off and screed to the appropriate cross section and to an elevation above grade which, when the concrete is consolidated and finished, will ensure that the surface of the pavement is at the exact elevation indicated on the drawings. Tamp the entire surface, and continue tamping until the required compaction and reduction of internal and surface voids are secured. Immediately after the final tamping of the surfaces, float the pavement longitudinally by hand. If contact with the pavement is not made at all points by the float, additional concrete shall be required and screeded, and the float operated until a satisfactory surface is obtained.

D. After the longitudinal floating is complete, eliminate minor irregularities and score marks remaining in the pavement surface by removing surplus material or, if necessary, by adding and working in freshly mixed concrete with long handled floats and filling in open textured areas in the pavement surfaces. Make the final finish with straightedges 8 feet in

length. A straightedge operated from the side of the pavement shall be equipped with a handle 3 feet longer than 1/2 of the pavement width. Place the straightedge at the centerline and pull uniformly to the edge. Do not advance the straightedge along the pavement in successive stages more than 1/2 its length. Immediately fill depressions with freshly mixed concrete, strike off, consolidate, and refinish. Remove projections above the required elevation while the concrete is still plastic and workable, doing so in a time sequence that will ensure the removal of all water and laitance from the surface. Continue the straightedge testing and refloating until the entire surface is free from observable departures from the straightedge, conforms to the required grade and contour, and will, when the concrete has hardened, conform with the surface requirements specified herein.

E. After hand finishing has been completed but before the concrete has attained initial set, carefully finish the edges of slabs along forms and at joints with an edging tool of 1/2-inch radius to form a smooth, rounded surface. Clean corners or edges of slabs that have crumbled and any areas that lack enough mortar for proper finishing by removing loose fragments and soupy mortar, and then fill solidly and finish with a mixture of the correct proportions and appropriate consistency. Eliminate unnecessary tool marks, and leave edges smooth and true to line. After removing the forms, fill any damaged or honeycombed areas with mortar composed of one part cement and two parts sand.

F. Form transverse and contraction joints in the finished pavement prior to initial set, spacing them as shown on the drawings. Contraction joints shall be 1/4-inch wide and 3/4-inch deep and shall be finished with an edging tool of 1/4-inch radius.

G. Place transverse and premolded expansion joints 1/2-inch thick in such a way that the joint will be filled to within 1/2 inch of the surface of the walk. Place them to full depth and normal to the grade. Wherever concrete walks abut against transverse steps, other walks, or adjacent structures, provide expansion joints. Clean all concrete from the top of the premolded joints and edge the concrete as specified above.

3.4 PROTECTION AND CURING

A. Protect and cure concrete with an approved curing compound applied according to the manufacturer's directions.

3.5 SURFACE TEST

A. Remove any portion of the pavement that shows a variation or departure greater than 1/4-inch from the testing edge of a 10 feet straightedge, and replace or correct as directed by the Engineer.

END OF SECTION 32 13 13

SECTION 32 16 00 – CURBS AND GUTTERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Standard specifications of the Tennessee Department of Transportation (TDOT) sections 702. Even though the weather limitations, construction methods, and materials specifications contained in the TDOT Specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this section, be considered as implied and therefore adhered to. However, the various subsections "Basis for Payment" contained in the TDOT specifications shall not be considered applicable.

C. ACI 301, Specifications for Structural Concrete for Buildings.

1.2 SUMMARY

A. Section includes installation of curbs and gutters as follows:

1. Installation of post curbs, extruded curbs, gutters, or combined curb and gutters.

B. Related Sections:

1. Section 310000 – Earthwork
2. Section 321313 – Concrete Paving.
3. Section 321616 – Asphalt Paving.

1.3 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Submit templates of the curb cross sections if alternates are proposed; these must be approved by the Owner or Owner's Representative prior to construction. Replace curbing that is installed without the Owner or Owner's Representative's approval.

1.4 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

B. An independent testing laboratory may be selected and paid by the Owner to perform construction testing. This does not relieve the Contractor of any quality assurance responsibilities.

C. Materials, sampling, and testing shall meet the applicable requirements of the Concrete Sections, ACI, and the latest revision of TDOT Section 501, 604, 702, and 905.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Concrete delivery, storage, and handling shall be in accordance with the latest edition TDOT specifications.

1.6 PROJECT CONDITIONS

A. Weather limitations for pavement to be properly placed, compacted, and finished shall be in accordance with the latest edition of the TDOT specifications, generally these are:

B. Do not place concrete when the ambient temperature is below 35 degrees F, nor when the concrete is, without special protections, likely to be subject to freezing temperatures before final setting has occurred. The temperature of the concrete when placed shall be not less than 50 degrees F, nor more than 90 degrees F. Heating of the mixing water and/or aggregates will not be permitted until the temperature of the concrete has decreased to 55 degrees F. Heated materials shall be free from ice, snow, and frozen lumps before entering the mixer. Methods and equipment for heating shall be subject to the Owner or Owner's Representative's approval. Provide suitable means for maintaining the concrete at a temperature of at least 40 degrees F for not less than 72 hours after placement. Any concrete damaged by freezing shall be removed and replaced at the expense of the Contractor.

C. Do not apply when base is wet, contains excess moisture, during rain, or when frozen.

D. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Concrete shall be f'c = 4,000 psi (unless otherwise shown on the Plans), as defined by ACI standards, air entrained. The applicable provisions of ACI 301, Specifications for Structural Concrete for Buildings, form a part of this specification. Concrete slump shall range from 0 to 3-in.

B. Joint Filler: Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal.

C. Joint Sealants: Conforming to ASTM D1190, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant", Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 245", or Woodmont Products "Chem-Caulk" or approved equal.

PART 3 - EXECUTION

3.1 SUBGRADE AND FORMS

A. Provide and operate a template for checking the contour of the subgrade. The template shall rest on the side forms and shall be provided with adjustable rods that project downward to the subgrade at 1 foot intervals. Adjust these rods to the required cross sections of the bottom of the slab when the template is supported at its sides.

B. Forms shall be of metal or wood and subject to approval by the Engineer.

C. The Contractor may elect to use extruded machine curb or curb and gutter. The Owner reserves the right to approve the machine used, the contour and finish of the curb and gutter, and the design mix and the right to designate the spacings for expansion and contraction joints.

D. Test the subgrade with respect to elevation and density prior to setting forms. Complete the subgrade to the plane of the typical sections shown on the drawings and to the lines and grades established by the drawings. Compact subgrades in accordance with the requirements in the Earthwork Section.

E. After preparing the subgrade as described above, set the forms. The subgrade under the forms shall be firm and cut true to grade so that each form section will, when placed, be firmly in contact for its entire length and base width. Stake the form into position so that the top, when tested by a 10 feet straightedge, conforms to the requirements specified for the surface of the concrete and so that the longitudinal axis of the upstanding leg does not vary more than 1/4 inch. Tightly lock form sections together.

F. Finish the subgrade to the exact section of the bottom of the pavement shown on the drawings. Wet the subgrade down far enough in advance of the placing of the concrete to ensure that it is firm and moist. In cold weather, the subgrade shall be entirely free from frost when the concrete is deposited.

G. Leave forms in place at least 24 hours after the concrete has been placed against them. Do not use crowbars or heavy tools against green concrete when removing the forms. Clean the forms well before reoiling and reuse.

3.2 PLACING

A. Concrete shall be in place within 45 minutes from the time all ingredients are charged in the mixing drum and before the concrete has obtained its initial set. Deposit concrete so that minimum handling will be necessary, and distribute it so that, when consolidated and finished, the slab thickness and surface grade required by the drawings will be obtained at all points. Place concrete rapidly and continuously between expansion joints. Use shovels for any necessary hand spreading. Consolidate the concrete adjacent to forms and joints with forks and spades.

B. Construct concrete curb or combination concrete curb and gutter, where specified on the Plans, in uniform sections of length specified on the Plans.

C. Form joints between sections either by steel templates, 1/8-inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2-inches below surface of curb and gutter; or with 3/4-inch thick performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold it's shape, but shall be removed while forms are still in place.

D. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on the Plans, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on the Plans.

E. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.

F. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.

G. Joint Sealants: Seal joints with approved exterior pavement joint sealants. Install in accordance with manufacturer's recommendations.

3.3 FINISHING

A. Immediately after placement, properly finish the concrete. The sequence of operations shall be as follows: hand finishing, longitudinal floating, straightedge finishing, and edging the joints.

B. Provide an approved hand strike template, approved tamping template, and a longitudinal float for the hand finishing of pavement. The templates shall be at least 1.0 foot longer than the pavement width and at least 4 inches wide. The longitudinal float shall be 6 feet to 8 feet long. The float shall be rigid and substantially braced and provided with suitable handles to ensure smooth and effective manipulation. The bottom edges of the base of the float shall be rounded. Floats made of metal or a combination of wood and metal may be used.

C. As soon as concrete is placed, strike off and screed to the appropriate cross section and to an elevation above grade which, when the concrete is consolidated and finished, will ensure that the surface of the pavement is at the exact elevation indicated on the drawings. Tamp the entire surface, and continue tamping until the required compaction and reduction of internal and surface voids are secured.

D. Form contraction joints in the finished concrete prior to initial set, spacing them as shown on the Plans. Unless otherwise noted, contraction joints shall be 1/4-inch wide at 10-ft. intervals.

E. Form expansion joints in the finished concrete prior to initial set, spacing them as shown on the Plans. Unless noted otherwise, premolded expansion joints shall be 3/4-inch thick at 100-ft. maximum spacing between joints. Provide expansion joints at tangent points of circular curbs, between curbs and rigid objects, at locations where stresses may develop, and wherever concrete abuts against transverse steps, walks, or adjacent structures.

F. Finish the edges of joints on ¼-in. radii. Clean all concrete from the top of the premolded joints.

3.4 PROTECTION AND CURING

A. Cure concrete with an approved curing compound applied according to the manufacturer's directions and as specified in “water-curing” section of ACI 308.

B. Protect the curbing until final acceptance. Repair sections that are damaged during this period by removing and reconstructing each 10-ft. section that has been damaged.

C. Backfill the curb immediately after the concrete has set sufficiently and after the forms have been removed. Place material in layers not exceeding 4-in. in loose thickness, and compact until firm and stable. Completely fill to the top of the back of curb and eliminate ponding behind the curbs.

END OF SECTION 321600

SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Painting and marking of pavements, curbs, guard posts, and light pole bases.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation (AASHTO)
1. AASHTO M248 - Ready-Mixed White and Yellow Traffic Paints

B. American Society for Testing and Materials (ASTM)
1. ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness by Notched Gauges.

C. Federal Specifications (FS)

1. FS A-A-2886 - Paint, Traffic, Solvent Based (supersedes FS TT-P-85 and FS TT-P-115, Type I)
2. FS TT-P-1952 - Paint, Traffic And Airfield Marking, Waterborne

1.3 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagme

1.05 QUALITY ASSURANCE

B. Use trained and experienced personnel in applying the products and operating the equipment required for pro

PART 2 - PRODUCTS

2.1 MATERIALS

A. Paint shall be waterborne or solvent borne, colors as shown or specified herein. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

B. Waterborne Paint: Paints shall conform to FS TT-P-1952.

C. Solvent Borne Paint: Paint shall conform to FS A-A-2883 or AASHTO M248. Paint shall be non-bleeding, quick-drying, and alkyd petroleum base paint suitable for traffic-bearing surface and be mixed in accordance with manufacture's instructions before application for colors White, Yellow, Blue, and Red.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the work area and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Sweep and clean surface to eliminate loose material and dust.

B. Where existing pavement markings are indicated on Construction Drawings to be removed or would interfe Within public rights-of-way, appropriate governing authority shall approve method of marking removal.

C. New pavement surfaces shall be allowed to cure for not less than 30 days before application of marking mater

3.3 CLEANING EXISTING PAVEMENT MARKINGS

A. In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or do not interfere with the adhesion of the new marking material do not require removal. Whenever grinding, scraping, sandblasting or other operations are performed, the work shall be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.4 APPLICATION

A. Apply two coats of paint at manufacturer's recommended rate, without addition of thinner, with maximum c mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use straightedge to ensure uniform, clean, and straight stripe.

B. Install pavement markings according to manufacturer's recommended procedures for the specified material.

C. Following items shall be painted with colors noted below:
1. Pedestrian Crosswalks: White
2. Exterior Sidewalk Curbs, Light Pole Bases, and Guard posts: Yellow
3. Fire Lanes: Red or per local code
4. Lane Striping where separating traffic moving in opposite directions: Yellow
5. Lane Striping where separating traffic moving in the same direction: White
6. ADA Symbols: Blue or per local code

7. ADA parking space markings as shown on the drawings.
8. Parking Stall Striping: Yellow, unless otherwise noted on Construction Drawings
9. Associate Parking Area: White, unless otherwise noted on Construction Drawings

3.5 FIELD QUALITY CONTROL

A. Inspection: After the paint has thoroughly dried, visually inspect the entire application and touch up as requir

B. Testing: Testing of wet film thickness shall be performed a minimum of two times on each parking row (including striped islands) and pedestrian cross walks, and a minimum of one test on each lane/alignment striping. At least one test shall be performed after refilling paint striping machine, changing operators of striping machine, and changing paint types, brands, etc. This shall be performed in addition to the testing stated above. These tests shall be performed on each coat applied. Testing shall be performed in accordance with ASTM D4414.

3.6 CLEANING

A. Waste materials shall be removed at the end of each workday. Upon completion of the work, all containers and debris shall be removed from the site. Paint spots upon adjacent surfaces shall be carefully removed by approved procedures that will not damage the surfaces and the entire job left clean and acceptable.

END OF SECTION 32 17 23

SECTION 32 32 23 – SEGMENTAL RETAINING WALL SYSTEM

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 furnishing and installing all selected Manufactured materials and Products, including but not limited to:
   1. Segmental Retaining Wall Units and Assemblies

B. Related Sections include the following:
   1. Division 00 General Conditions
   2. Division 01 Substitutions
   3. Division 31 Earthwork
   4. Division 32 Exterior Improvements

1.3 REFERENCE STANDARDS

A. Segmental Retaining Wall Units
   1. ASTM C 140 - Sampling and Testing Concrete Masonry Units
   2. ASTM C 1372 – Standard Specification for Dry-Cast Segmental Retaining Wall Units

B. Geosynthetic Reinforcement:
   1. ASTM D 4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
   2. ASTM D 5262 – Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics
   3. ASTM D 5321 – Standard Test Method For Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic by Direct Shear Method
   4. ASTM D 5818 - Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
   5. ASTM D 6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

C. Soils
   1. ASTM D 698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
   2. ASTM D 2487 – Standard Practice for Classification of Soils for Engineering Purposes
   3. ASTM D 422 – Standard Test Method for Particle-Size Analysis of Soils

4. ASTM D 4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
5. ASTM G 51 – Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing

D. Drainage Pipe
1. ASTM F 758– Standard Specification for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport or Similar Drainage
2. ASTM F 405 – Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings

1.4 SUBMITTALS

A. Materials Submittals: The Contractor shall submit manufacturers' certifications two weeks prior to start of work stating that the Segmental Retaining Wall units and geosynthetic reinforcement meet the requirements of Section 2 of this specification.

B. Design Submittal: The Contractor shall submit two sets of detailed design calculations and final retaining wall plans for approval at least two weeks prior to the beginning of wall construction. All calculations and drawings shall be prepared and sealed by a professional Civil Engineer (P.E.) – (Wall Design Engineer) experienced in Segmental Retaining Wall design and licensed in the state where the wall is to be built utilizing information found in the Geotechnical Report as provided by the owner.

C. Provide Qualification of Installers.

D. Shop drawings shall include the following note completed and signed by the Contractor:
1. THE DATA SUBMITTED DOES NOT CONTAIN MATERIAL DEVIATION FROM REQUIREMENTS OF CONTRACT DOCUMENTS EXCEPT AS FOLLOWS.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements

B. Mockups: Build mockups Indicate portion of Work represented by mockup on Drawings or draw mockup as separate element.
1. Build mockup of section as shown on Mock-up Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRE-INSTALLATION MEETINGS

A. Conduct the conference at the job site on a date and time set a minimum of 2 weeks in advance of beginning work.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, Installer, system manufacturer's representative, grading contractor, and installers whose work interfaces with or affects the wall transition to the windows.
   2. Review methods and procedures related to installation, including manufacturer's written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine substrate and surrounding conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of walls and windows during and after installation.

B. Review governing regulations and requirements for insurance and certificates if applicable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall check materials upon delivery to ensure that the specified type and grade of materials have been received and proper color and texture of Segmental Retaining Wall units have been received.

B. Contractor shall store and handle materials in accordance with manufacturer’s recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping or other causes.

C. Contractor shall prevent excessive mud, wet concrete, epoxies and similar materials that may affix themselves from coming in contact with materials.

D. Contractor shall protect materials from damage; no damaged material shall be incorporated into the segmental wall.

E. Geosynthetic shall be protected from UV exposure and the protective covering on geosynthetic shall remain until immediately before installation and shall be stored at temperatures above -10 degrees F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, basis of design: Product specifications are based upon the first named manufacturer. Subject to compliance with requirements, manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Versa Lok Retaining Wall Units
2. Keystone Retaining Wall Units

B. Substitutions will only be permitted if the procedures are followed in Division 01.

2.2 MATERIALS

A. Segmental Retaining Wall units shall be machine formed, Portland cement concrete blocks specifically designed for retaining wall applications.

B. Size and Color to be selected by architect from manufacturer's options based on design recommendations from the manufacturer's offerings and the civil engineer who performed the calculations.

C. Finish of Segmental Retaining Wall units shall be smooth with three beveled edges.

D. Segmental Retaining Wall unit faces shall be of straight geometry.

E. Segmental Retaining Wall unit height shall be 8 inches.

F. Segmental Retaining Wall units (not including aggregate fill in unit voids) shall provide a minimum weight of 180 psf wall face area.

G. Segmental Retaining Wall units shall be solid through the full depth of the unit.

H. Segmental Retaining Wall units shall have a depth (front face to rear) -to-height ratio of 2.25:1, minimum.

I. Segmental Retaining Wall units shall be interlocked with connection pins, designed to allow for vertical and setback configurations.

J. Segmental Retaining Wall units shall be capable of being erected with the horizontal gap between adjacent units not exceeding 1/8 inches.

K. For any corners shown on the construction plans, Segmental Retaining Wall units shall be capable of providing overlap of units on each successive course so that walls meeting at corner are interlocked and continuous. Segmental Retaining Wall units that require corners to be mitered shall not be allowed.

L. Units shall be capable of being erected with a variable bond configuration, between ¼ to ¾ bond.

M. Segmental Retaining Wall units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the structure. Any cracks or chips observed during construction shall fall within the guidelines outlined in ASTM C 1372.

N. Concrete Segmental Retaining Wall units shall conform to the requirements of ASTM 1372 and have a minimum net average 28 days compressive strength of 3000 psi. Compressive strength test specimens shall conform to the saw-cut coupon provisions of ASTM C140.

O. Segmental Retaining Wall units' molded dimensions shall not differ more than + 1/8 inch from that specified, as measured in accordance with ASTM C 140.

2.3 ACCESSORY MATERIALS

A. Retaining Wall Pins: units shall be interlocked with connection pins. The pins shall consist of glass-reinforced nylon made for the expressed use with the units supplied.

B. Geosynthetic Reinforcement: Geosynthetic reinforcement shall consist of geogrids or geotextiles manufactured as a soil reinforcement element. The manufacturers/suppliers of the geosynthetic reinforcement shall have demonstrated construction of similar size and types of segmental retaining walls on previous projects.
   1. The geosynthetic type must be approved one week prior to bid opening. Geosynthetic types currently approved for this project are VERSA-Grid Geogrids.
   2. The type, strength and placement location of the reinforcing geosynthetic shall be as determined by the Wall Design Engineer, as shown on the final, P.E.-sealed retaining wall plans.

C. Leveling Pad: Material for leveling pad shall consist of compacted sand, gravel, or combination thereof (USCS soil types GP,GW, SP, & SW) and shall be a minimum of 6 inches in depth. Lean concrete with a strength of 200-300 psi and 3 inches thick maximum may also be used as a leveling pad material. The leveling pad should extend laterally at least a distance of 6 inches from the toe and heel of the lowermost unit.

D. Drainage Aggregate: Drainage aggregate shall be angular, clean stone or granular fill meeting the following gradation as determined in accordance with ASTM D422

Sieve Size	Percent Passing
1 inch	100
3/4 inch	75-100
No. 4	0-60
No. 40	0-50
No. 200	0-5

E. Drainage Pipe: The drainage collection pipe shall be a perforated or slotted PVC, or corrugated HDPE pipe. The drainage pipe may be wrapped with a geotextile to function as a filter.
   1. Drainage pipe shall be manufactured in accordance with ASTM D 3034 and/or ASTM D 1248.

F. Reinforced Soil: The reinforced soil material shall be free of debris. Unless otherwise noted on the final, P.E.-sealed, retaining wall plans prepared by the Wall Design Engineer, the reinforced material shall consist of the inorganic USCS soil types GP, GW, SW, SP, SM, meeting the following gradation, as determined in accordance with ASTM D422:

1.

Sieve Size	Percent Passing
1 inch	100
No. 4	20-100
No. 40	0-60
No. 200	0-35

2. The maximum particle size of poorly-graded gravels (GP) (no fines) should not exceed 3/4 inch unless expressly approved by the Wall Design Engineer and the long-term design strength (LTDS) of the geosynthetic is reduced to account for additional installation damage from particles larger than this maximum.
3. The plasticity of the fine fraction shall be less than 20.

G. Geotextile Filter: Drainage geotextile shall consist of geosynthetic specifically manufactured for use as a preamble soil filter that retains soil while still allowing water to pass throughout the life of the structure. The type and placement of the geotextile filter material shall be as required by the Wall Design Engineer in their final wall plans and specifications.

PART 3 - EXECUTION

3.1 DESIGN PARAMETERS

A. The soil parameters shall be taken from the Geotechnical Report as provided by the owner.

B. Should the actual soil conditions observed during construction differ from those assumed for the design, design shall be reviewed by the Wall Design Engineer at the Owner's Geotechnical Engineer's direction.

3.2 DESIGN

A. The design analysis for the final, P.E.-sealed retaining wall plans prepared by the Wall Design Engineer shall consider the external stability against sliding and overturning, internal stability and facial stability of the reinforced soil mass and shall be in accordance with acceptable engineering practice and these specifications. The internal and external stability analysis shall be performed in accordance with the “NCMA Design Manual for Segmental Retaining Walls,” using the recommended minimum factors of safety in this manual.

B. External stability analysis for bearing capacity, global stability, and total and differential settlement shall be the responsibility of the Owner and the Owner's Geotechnical Engineer. Geotechnical Engineer shall perform bearing capacity, settlement estimates, and global stability analysis based on the final wall design

provided by the Wall Design Engineer and coordinate any required changes with Wall Design Engineer.

C. While vertical spacing between geogrid layers may vary, it shall not exceed 2.0 feet and 2.7 feet maximum for vertical and setback options, respectively, in the wall design.

D. The geosynthetic placement in the wall design shall have 100% continuous coverage parallel to the wall face. Gapping between horizontally adjacent layers of geosynthetic (partial coverage) will not be allowed.

3.3 CONSTRUCTION

A. Inspection: The Owner or Owner's Representative is responsible for verifying that the Contractor meets all the requirements of the specification. This includes all submittals for materials and design, qualifications, and proper installation of wall system.
   1. Contractor's field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

B. Excavation: Contractor shall excavate to the lines and grades shown on the project grading plans. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted infill material, or as directed by the Engineer/Architect, at the Contractor's expense.
   1. Contractor shall verify location of existing structures and utilities prior to excavation. Contractor shall ensure all surrounding structures are protected from the effects of wall excavation. Excavation support, if required, is the responsibility of the Contractor.

C. Foundation Preparation: Following the excavation, the foundation soil shall be examined by the Owner's Engineer to assure actual foundation soil strength meets or exceeds the assumed design bearing strength. Soils not meeting the required strength shall be removed and replaced with infill soils, as directed by the Owner's Engineer.
   1. Foundation soil shall be proof-rolled and compacted to 95% standard Proctor density and inspected by the Owner's Engineer prior to placement of leveling pad materials.

D. Leveling Pad Construction: Leveling pad shall be placed as shown on the final, P.E.-sealed retaining wall plans with a minimum thickness of 6 inches. The leveling pad should extend laterally at least a distance of 6 inches from the toe and heel of the lowermost unit
   1. Granular leveling pad material shall be compacted to provide a firm, level bearing surface on which to place the first course of units. Well-graded sand can be used to smooth the top 1/4 inch to 1/2 inch of the leveling pad. Compaction will be with mechanical plate compactors to achieve 95% of maximum standard Proctor density (ASTM D 698).

E. Segmental Retaining Wall Unit Installation: All segmental retaining wall units shall be installed at the proper elevation and orientation as shown on the final, P.E.-

sealed wall plans and details or as directed by the Wall Design Engineer. The segmental retaining wall units shall be installed in general accordance with the manufacturer's recommendations. The specifications and drawings shall govern in any conflict between the two requirements.

1. First course of segmental retaining wall units shall be placed on the leveling pad. The units shall be leveled side-to-side, front-to-rear and with adjacent units, and aligned to ensure intimate contact with the leveling pad. The first course is the most important to ensure accurate and acceptable results. No gaps shall be left between the front of adjacent units. Alignment may be done by means of a string line or offset from base line to the back of the units
2. All excess debris shall be cleaned from top of units and the next course of units installed on top of the units below.
3. Two Brute connection pins shall be inserted through the pin holes of each upper-course unit into receiving slots in lower-course units. Pins shall be fully seated in the pin slot below. Units shall be pushed forward to remove any looseness in the unit-to-unit connection.
4. Prior to placement of next course, the level and alignment of the units shall be checked and corrected where needed.
5. Layout of curves and corners shall be installed in accordance with the wall plan details or in general accordance with segmental retaining wall manufacturer’s installation guidelines. Walls meeting at corners shall be interlocked by overlapping successive courses.
6. Procedures for construction shall be repeated until reaching top of wall units, just below the height of the cap units. Geosynthetic reinforcement, drainage materials, and reinforced backfill shall be placed in sequence with unit installation as described herein.

F. Geosynthetic Reinforcement Placement: All geosynthetic reinforcement shall be installed at the proper elevation and orientation as shown on the final P.E.-sealed retaining wall plan profiles and details, or as directed by the Wall Design Engineer.

1. At the elevations shown on the final plans, (after the units, drainage material and backfill have been placed to this elevation) the geosynthetic reinforcement shall be laid horizontally on compacted infill and on top of the concrete segmental retaining wall units, to within 1 inch of the front face of the unit below. Embedment of the geosynthetic in the segmental retaining wall units shall be consistent with segmental retaining wall manufacturer’s recommendations. Correct orientation of the geosynthetic reinforcement shall be verified by the Contractor to be in accordance with the geosynthetic manufacturer’s recommendations. The highest-strength direction of the geosynthetic must be perpendicular to the wall face.
2. Geosynthetic reinforcement layers shall be one continuous piece for their entire embedment length. Splicing of the geosynthetic in the design-strength direction (perpendicular to the wall face) shall not be permitted. Along the length of the wall, horizontally adjacent sections of geosynthetic reinforcement shall be butted in a manner to assure 100% coverage parallel to the wall face.
3. Tracked construction equipment shall not be operated directly on the geosynthetic reinforcement. A minimum of 6 inches of backfill is required

prior to operation of tracked vehicles over the geosynthetic. Turning should be kept to a minimum. Rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds (less than 5 mph).

4. The geosynthetic reinforcement shall be free of wrinkles prior to placement of soil fill. The nominal tension shall be applied to the reinforcement and secured in place with staples, stakes or by hand tensioning until reinforcement is covered by 6 inches of fill.

G. Drainage Materials: Drainage aggregate shall be installed to the line, grades and sections shown on the final P.E.-sealed retaining wall plans. Drainage aggregate shall be placed to the minimum thickness shown on the construction plans between and behind units (a minimum of 1 cubic foot for each exposed square foot of wall face unless otherwise noted on the final wall plans).

1. Drainage collection pipes shall be installed to maintain gravity flow of water outside the reinforced-soil zone. The drainage collection pipe shall daylight into a storm sewer or along a slope, at an elevation below the lowest point of the pipe within the aggregate drain.

H. Backfill Placement: The reinforced backfill shall be placed as shown in the final wall plans in the maximum compacted lift thickness of 10 inches and shall be compacted to a minimum of 95% of standard Proctor density (ASTM D 698) at a moisture content within -1% point to +3% points of optimum. The backfill shall be placed and spread in such a manner as to eliminate wrinkles or movement of the geosynthetic reinforcement and the units.

1. Only hand-operated compaction equipment shall be allowed within 3 feet of the back of the wall units. Compaction within the 3 feet behind the wall units shall be achieved by at least three passes of a lightweight mechanical tamper, plate, or roller.
2. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing and reinforced backfill to direct water runoff away from the wall face.
3. At completion of wall construction, backfill shall be placed level with final top of wall elevation. If final grading, paving, landscaping and/or storm drainage installation adjacent to the wall is not placed immediately after wall completion, temporary grading and drainage shall be provided to ensure water runoff is not directed at the wall nor allowed to collect or pond behind the wall until final construction adjacent to the wall is completed.

I. Segmental Retaining Wall Caps: caps shall be properly aligned and glued to underlying units with manufacturer’s approved adhesive, a flexible, high-strength concrete adhesive. Rigid adhesive or mortar are not acceptable.

1. Caps shall overhang the top course of units by 3/4 inch to 1 inch. Slight variation in overhang is allowed to correct alignment at the top of the wall.

J. Construction Adjacent to Completed Wall: The Owner is responsible for ensuring that construction by others adjacent to the wall does not disturb the wall or place temporary construction loads on the wall that exceed design loads, including loads such as water pressure, temporary grades, or equipment loading. Heavy paving or grading equipment shall be kept a minimum of 3 feet behind the back of the wall face. Equipment with wheel loads in excess of 150 psf live load shall

not be operated within 10 feet of the face of the retaining wall during construction adjacent to the wall. Care should be taken by the General Contractor to ensure water runoff is directed away from the wall structure until final grading and surface drainage collection systems are completed.

END OF SECTION 32 32 23

SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. Supplying and placing soil additives, seed, and mulch as specified on prepared ground in accordance with the Plans and these Specifications.
2. Sodding or seeding all non-construction areas that show signs of excessive erosion and all newly graded earthen areas that are not to be paved, stabilized unless otherwise indicated on the Plans or as directed by the Engineer.

B. Related Sections:

1. Section 310000 - Earthwork

1.3 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

1.4 QUALITY ASSURANCE

A. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Do not disturb any areas outside the work area as defined on the Plans. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of materials shall be in accordance with the Contract Documents and the local, State, and Federal requirements.

1.6 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grass Seed: Seed mixture shall be fresh, clean, new crop seed. Grass shall be of the previous year's crop and in no case shall the weed seed content exceed 0.25% by weight. The seed shall be furnished and delivered in the proportion specified below in new, clean, sealed, and properly marked containers. Seed shall comply with State and Federal seed laws. Seed that has become wet, moldy, or otherwise damaged will not be accepted. All Fescues shall contain Acromonium endophytes. Seed containing endophyte must be kept cool and dry at all times; do not stockpile in the sun. Seed mixture for general lawn conditions shall be as follows:

Common Name	Proportion By Weight	Germination Minimum	Purity Minimum
Tall Fescue	50%	85%	95%
Chewings Fescue	25%	85%	95%
Creeping Red Fescue	25%	85%	95%

1. Tall fescue shall be improved turf-type blends. Kentucky 31 tall fescue shall not be used.
2. Provide 3 varieties minimum for each Fescue species.
3. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on the site, each variety shall be delivered in the original containers that shall bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, provide the dealer's guaranteed statement of the composition of the mix.

B. Fertilizer: Use a slow-release starter fertilizer in standard containers that are clearly marked with name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling; and in compliance with all local, state, and federal fertilizer laws.

C. Lime: Use lime containing a minimum of 85% calcium carbonate and magnesium carbonate and shall be ground to such fineness that 40% will pass the No. 100 mesh sieve and 95% of which will pass through the No. 20 mesh sieve. Contractor shall be aware of loam borrow pH and the amount of lime needed to adjust pH to specifications in accordance with testing lab recommendations.

D. Mulch: Stalks of rye, oats, wheat, or other approved grain crops properly cured prior to baling, air dried, and reasonably free of noxious weeds and weed seeds or other material detrimental to plant growth.

E. Water: The Contractor shall be responsible to furnish their supply of water to the site at no additional cost. If possible, the Owner may furnish the Contractor upon request with an adequate source and supply of water at no charge. However, if the Owner's water supply is not available or not functioning, the Contractor shall be responsible to furnish adequate supplies at their cost. All work injured or damaged due to the lack of water or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.

F. Matting: provide matting as shown on the Plans for slopes steeper than 3:1 or as otherwise specified on the Plans.

PART 3 - EXECUTION

3.1 GENERAL

A. Before starting seeding operations on any area, final dressing and placing of topsoil shall have been completed in accordance with the applicable Specifications. Seed, fertilize, lime, and mulch within 30 days of attainment of finish grade.

B. Apply temporary seeding whenever grading operations are temporarily halted for over 14 days and final grading of exposed surfaces is to be completed within one year. Also apply temporary seeding to soil stockpiles.

3.2 PREPARATION

A. Each area to be seeded shall be scarified, disked, harrowed, raked or otherwise worked until it has been loosened and pulverized to a depth of not less than 2 inches and brought to the lines and grades indicated on the Plans or directed by the Engineer. This operation shall be performed only when the soil is in a tillable and workable condition.

B. Apply fertilizer at the rate of 1 pound of nitrogen per 1,000 square feet, and lime at the rate of 50 pounds per 1,000 square feet, shall be uniformly incorporated in the soil for a depth of approximately 1inch. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. Do not apply lime without a soil test.

3.3 SEEDING

A. Seed shall be sown as soon as preparation of the seed bed has been completed. It shall be sown uniformly by means of a rotary seeder or other satisfactory means. Seed shall be sown at the rate of 8 pounds per 1,000 square feet. Hydro-seeding is not allowed.

B. No seeding shall be done during windy weather or when the ground surface is frozen, wet or otherwise non-tillable.

C. When seeding during February 1 through April 1 and October 1 through November 30, add an additional 3 pounds per 1000 square feet of annual rye grass. No seeding shall be performed during December and January unless otherwise permitted.

3.4 MULCHING

A. When the mulching material is hay or straw, it shall be spread evenly over the seeded area at an approximate rate of 2 bales (100 pounds minimum) per 1,000 square feet for straw and 150 pounds per 1,000 square feet for hay immediately following the seeding operations. The Engineer depending on the texture and condition of the mulch material and the characteristics of the area seeded may vary this rate.

3.5 MAINTANENCE

A. All seeded areas shall be cared for properly to the Owner or Owner's Representative's satisfaction until acceptance of the work. Areas, which have been previously seeded and mulched in accordance with this Section, but which, have been damaged or failed to successfully establish an acceptable stand of grasses shall be repaired as directed by the Owner or Owner's Representative. All material and labor required to repair seeded areas made necessary by negligence on a part of the Contractor will be furnished by the Contractor at no cost.

B. If within 60 days of the planting less than 50% is successful, rework the ground, refertilize, reseed, and remulch.

3.6 CLEANUP AND PROTECTION

A. After the completion of seeding, the area shall be cleaned of all rubbish, excess material, and any other items that will mar the appearance of the projects as in accordance with the General Specifications.

END OF SECTION 32 92 19

SECTION 33 11 00 – WATER UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. The work covered by this section shall consist of the furnishing and installation of water lines.

2. The Contractor shall be responsible for safely storing materials needed for the work until they have been incorporated into the completed project.

B. Related Sections:

3. Section 310000 – Earthwork for excavation (defined as unclassified) for pipe trenches and structures and backfill.

1.3 DEFINITIONS

A. The length of pipe as shown on the Plans is based on its in place length as measured along the centerline with no deductions for appurtenances. Actual quantity of pipe may vary; supply and install the necessary quantity of pipe to construct the complete system.

1.4 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Submit shop drawings for material substitutions. Do not submit shop drawings for materials that are consistent with the plans. These submittals will be marked "Not Requested for Review" and returned.

1.5 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

1.6 DELIVERY, STORAGE, & HANDLING

A. Delivery, storage, and handling shall be in accordance with these specifications and the manufacturer's requirements.

B. All pipe, structures, and appurtenances shall be inspected and accepted by an approved commercial testing laboratory prior to delivery to the work site. Each joint and each structure shall be stenciled or otherwise marked with the laboratory's mark of acceptance. Furnish the Engineer with a certified copy (via email) of the laboratory's report of inspection, test, and acceptance on all pipe and appurtenances prior to its incorporation in the work.

1.7 PROJECT CONDITIONS

A. Verify the locations of the existing underground utilities by contacting the utility owners and by potholing in the field.

B. Notify the utility owners prior to beginning work.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. All materials will be visually inspected by the Owner at the site for conformance to the specifications. At the Owner's discretion, the Contractor may be required to supply certified mill tests, samples, or other suitable form of verification that the material meets the required specifications.

B. Ductile Iron Pipe (DIP): DIP shall be made of good quality ductile iron in conformance with the latest revision of ANSI/AWWA C151/A21.51 Standard. The pipe shall be push-on joint with a minimum pressure class of 150 psi, cement-lined according to ANSI 21.4/AWWA C-104, and coated inside and outside with an asphaltic coating. Ductile iron pipe and fittings shall conform to the requirements of the Materials Specifications herein.

C. PVC pipe (2-inch diameter) and fittings shall be NSF-Approved Class 200 or Class 250 as required by Owner in high pressure areas. The pipe shall be manufactured from Class 12454-B polyvinyl chloride plastic (PVC 1120) as defined by ASTM D1784, and in accordance with ASTM D2241 and the Materials Specifications herein.

D. Copper pipe (2-inch diameter) shall be Type-K copper, annealed, and meeting ASTM B88, latest revision. Furnished in 20-foot straight laying lengths, and in conformance with the Materials Specifications herein.

PART 3 - EXECUTION

3.1 INSTALLATION OF WATER LINES

A. All water lines greater than 2 inches in diameter shall be ductile iron pipe. Water lines 2 inches in diameter shall be approved by the Owner, and shall be copper pipe under roadway pavement or in bores and tunnels. Either copper pipe or PVC pipe may be used elsewhere.

B. All 2-inch PVC pipe shall be installed with a 14-gauge copper wire which shall be tied into metallic mains and valve boxes.

C. Water lines shall be installed as shown on the drawings. All fittings, valves, and hydrants shall be at the required locations, the spigots centered in the bells, and all valves and hydrant stem plumb.

D. Timing and procedures of pipe installations, valve closings, temporary services, and interruption of services shall be approved by and coordinated with the Owner. The Owner may require that the work be performed during non-business hours if necessary to maintain services.

E. Unless otherwise indicated by the drawings, all water lines shall have at least 36 inches of cover. Exceptions shall be approved by the Owner.

F. The maximum trench width for water line installations shall be 24″ for 6″ and 8″ lines, 30″ for 10″ and 12″ lines, 36″ for 16″ and 24″ lines, and 54″ for 30″ lines. Trench widths for larger sizes shall be approved by the Owner.

G. The Contractor shall provide and use tools and facilities that are satisfactory to the Owner and that will allow the work to be done in a safe and convenient manner. All pipe, fittings, valves, and hydrants are to be unloaded from the trucks using suitable tools and equipment. A derrick, ropes, or other suitable tools or equipment shall be used to lower all pipe, fittings, valves, and hydrants into the trench one piece at a time. Each piece shall be lowered carefully so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances shall water line materials be dropped or dumped.

H. Any pipes strung out along the route of the proposed lines before the actual installation of those lines is due to take place shall not be lowered into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. PVC pipe shall be strung out a maximum of one day ahead of pipe laying. All unnecessary material shall be removed from the bell and spigot end of each pipe. Before any pipe is

laid, the outside of its spigot end and the inside of its bell shall be cleaned and left dry and oil-free.

I. Every precaution shall be taken to keep foreign material from getting into the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe during laying operations.

J. After a length of pipe has been placed in the trench, the spigot end shall be centered in the bell of the adjacent pipe, and then inserted to the depth specified by the manufacturer.

K. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, the bottom of the trench shall be carefully graded so that each pipe barrel will rest on a solid foundation for its entire length.

L. Whenever pipe laying is not in progress, the open ends of the pipe shall be closed either with a watertight plug or by other means approved by the Owner.

M. Pipe shall be cut so that valves, fittings, or closure pieces can be inserted in a neat and workmanlike manner and without any damage to the pipe. The manufacturer's recommendations shall be followed concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis. For cast iron pipe, hydraulic cutters or a carborundum saw shall be used. A carborundum saw shall be used for ductile iron pipe. A handsaw or chisel shall be used for asbestos-cement and PVC pipe. The Owner may consider other methods for 12-inch diameter and larger pipe.

N. Pipe shall be installed with the bell ends facing in the direction of laying unless otherwise directed by the Owner.

O. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions, or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the Owner. Bend fittings shall only be used when the pipe deflections are inadequate, according to manufacturer's recommendations, or as directed by the Owner.

P. Thrust blocks shall be installed wherever the water main changes direction (at tees and bends), at dead ends, or at any other point recommended by the manufacturer or required by the Owner. Thrust blocks shall be considered an integral part of the water line work. Where thrust blocking is inadequate or inappropriate, tie rods shall be installed.

Q. No pipe shall be installed in water or when it is the Owner's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project.

R. Water lines shall be designed with a 10-foot horizontal separation from any existing or proposed sewer main. If this is not practical, the water main may be placed closer than 10

feet from a sewer main, provided it is laid in a separate trench and that the elevation of the top of the sewer is at least 18 inches below the bottom of the water main, or as directed by the Owner.

S. Where a water main crosses over a sewer, the top of the sewer shall be at least 18 inches below the bottom of the water main. If the elevation of the lines cannot be adjusted to meet the 18-inch separation, then the water main shall be constructed with ductile iron pipe for a distance of 10 feet on either side of the sewer, with a full pipe section centered over the sewer, or as directed by the Owner.

T. All pipe shall be jointed in the exact manner specified by the manufacturers of the pipe and jointing materials.

U. All water distribution mains shall be flushed prior to inspection as specified below to assure complete removal of all debris and foreign material.

V. On water lines to be abandoned, all water appurtenances shall be removed to a minimum depth of 6 inches below the proposed grade and backfilled in accordance with the Earthwork section.

3.2 LEAKAGE TEST

A. All newly installed and backfilled pipe or any valved section thereof shall be subjected to a leakage test, conducted in the presence of the Owner. If testing against a previously existing valve and the valve leaks, the Owner shall be responsible for repairing the valve. However, the Owner shall not be liable for costs or lost time incurred by the Contractor when attempting to test a line against a faulty valve.

B. Each valved section of pipe shall be slowly filled with water, and a test pressure equal to the normal working pressure (but not less than 150 psi) shall be applied. Test pressure shall be based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge. A pump shall be connected to the pipe in a manner satisfactory to the Owner. The Contractor shall furnish the labor and equipment, including the pump, pipe, connections, gauges, and all necessary apparatus.

C. Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blowoffs are not available at high places, the necessary taps shall be made by the Contractor at the points of highest elevation before testing, and plugs shall be inserted by the Contractor after the test has been completed.

D. The leakage test shall be conducted by measuring, through a calibrated meter, the amount of water which enters the test section under 150 psi or normal working pressures, whichever is greater, for a period of at least 2 hours. No installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = \frac{NDP^{1/2}}{7400}$$

L = allowable leakage gallons/hour
N = number of joints in length of pipeline tested
D = nominal diameter at the pipe, inches
P = average test pressure during the leakage test, psig

The following table has been developed for the commonly used sizes of ductile iron pipe, with a nominal laying length of 20 feet, under a test pressure of 150 psi. The leakage formula above may be used when conditions differ from those stated parameters.

Pipe Diameter (Inches)	Allowable Leakage per 100 feet (Gallons/hr)
8	0.26
12	0.40
16	0.53
20	0.66
24	0.79
30	0.99
36	1.19

E. Any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this leakage test shall be replaced with sound material in the manner specified at no cost to the OWNER. The test shall be repeated until the results are satisfactory to the OWNER.

3.3 DISINFECTION

A. If dirt or other foreign material that has gotten into a pipe will not, in the opinion of the OWNER, be removed by flushing, the interior of the pipe shall be cleaned and swabbed with a disinfecting solution of 5% hypochlorite.

B. Water shall be diverted into the pipe in a manner approved by OWNER. Chlorine additives shall be so proportioned that the chlorine concentration is kept at a minimum of 50 mg/l available chlorine.

C. Table I shows how much chlorine is needed for each 100 feet of line for pipes of various diameters. A 1% chlorine solution may be prepared either with 1 pound of calcium hypochlorite for each 8.5 gallons of water or with sodium hypochlorite.

Table 1

Chlorine Required to Produce a 50 mg/L Concentration
in 100 Feet of Pipe, by Diameter

Pipe Size (Inches)	100% Chlorine (Pounds)	1% Chlorine Solutions (Gallons)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.328	3.96
16	0.428	5.12
18	0.540	6.48
20	0.680	8.00
24	0.980	11.52

D. While the chlorine is being applied, manipulate valves under the direction of the Utility so that the treatment dosage will not flow back into the line that is supplying the water. The OWNER shall continue the application of chlorine until the entire line being treated is filled with the chlorine solution. Then the Contractor shall retain the chlorinated water in the line for at least 24 hours, during which time all valves and hydrants in the line being treated shall be operated so that appurtenances can also be disinfected. After 24 hours, the treated water shall have a chlorine concentration of at least 25 mg/l throughout the line.

E. After the applicable retention period, the Contractor shall flush the heavily chlorinated water from the line until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. The drainage and as approved by the Owner. The velocity of the water used to flush a line shall be at least 2.5 fps. The flow rates required to produce this velocity in various sizes of pipe are shown in Table II.

Table 2
Required Openings to Flush Pipelines
(40 psi Residual Pressure)

Pipe Size (Inches)	Flow Required To Produce 2.5 fps Velocity (gpm)	Orifice Size (Inches)	Hydrant Outlet Number	Hydrant Nozzles Size (Inches)
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2

12	880	2-13/16	1	2-1/2
14	1,200	3-1/4	2	2-1/2
16	1,565	3-5/8	2	2-1/2
18	1,980	4-3/16	2	2-1/2
20	2,440	-------	2	2-1/2
24	3,470	-------	2	2-1/2

F. Once a line has been flushed, the OWNER shall test to make certain that the residual chlorine in the water is within acceptable limits.

G. It must be noted that flushing is no substitute for taking preventative measures before and during the laying of water lines. Certain contaminants, especially those in caked deposits, are difficult or even impossible to remove by flushing, no matter how high the velocity. Furthermore, in pipes with diameters of 16 inches or more, it can be difficult to achieve even the minimum recommended flushing velocity of 2.5 fps.

3.4 BACTERIAL TESTS

A. After a water line has undergone final flushing but before it is placed into service, the Utility shall collect a sample for bacteriological testing from the end of that line. In the case of extremely long lines, additional samples may be collected.

B. Samples will be collected in sterile bottles containing sodium thiosulfate. A hose or fire hydrant shall not be used to collect samples.

END OF SECTION 33 11 00

SECTION 33 12 16 – WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers valves for the pump station and waterlines.

1.2 RELATED SECTIONS

A. Section 33 11 00, Water Utility Distribution Piping.

PART 2 PRODUCTS

2.1 RESILENT SEATED GATE VALVES

A. Gate Valves shall be resilient seated, manufactured to meet or exceed the latest requirements of AWWA C509 and in accordance the materials specifications.

B. Valves shall have an unobstructed waterway not less than the full nominal diameter of the valve.

C. The valves shall be non-rising stem with the stem made of cast, forged, or rolled bronze. Two stem seals of the O-ring type shall be provided to prevent leakage around the stem.

D. The stem nut, also made of bronze, may be independent of the gate or cast integrally with the gate. If the stem nut is cast integrally, the threads shall be straight and true with the axis of the stem to avoid binding during the opening or closing of the valve.

E. The sealing mechanism shall consist of a cast iron gate having a vulcanized synthetic rubber coating or a rubber seat mechanically retained on the gate. The resilient sealing mechanism shall provide zero leakage at 200 psi working pressure when installed with the line flow in either direction.

F. The valve body, bonnet, and bonnet cover shall be cast iron, ASTM A126, Class B or ductile iron per ASTM A536.

G. All valves shall be in strict accordance with AWWA C509.

H. Buried valves shall have integrally cast mechanical joint ends in accordance with AWWA C111 and 2-inch square wrench nut operators. Mechanical accessories shall be supplied by the valve manufacturer. Exposed valves in structures shall have flanged ends and removable hand wheel operators. The direction of opening for either type of valve shall be counterclockwise as viewed from the top.

I. All ferrous surfaces of the valve body, both inside and outside, shall be protected by a fusion-bonded epoxy coating.

J. Markings shall be cast on the bonnet or body of each valve to identify the size, working pressure, year of manufacturer, and manufacturer of valve.

2.2 CHECK VALVES

A Check valves shall be constructed with a cast iron or cast steel body with a bronze or stainless steel seat ring, a non-corrodible shaft for attachment of weight and lever, and complete non-corrodible cushion chamber.

B. Check valves shall absolutely prevent the return of water back through the valve when the inlet pressure decreases below the delivery pressure. The valve must be tight seating and must operate without hammer or shock. The seat ring must be renewable and shall be securely held in place by a threaded joint.

C. The cushion chamber shall be attached to the side of the valve body externally and constructed with a piston operating in a chamber that will effectively permit the valve to operate without any hammering action. The cushioning shall be by air, and the cushion chamber shall be arranged so that the closing speed will be adjustable to meet the service requirements.

D. The valve disc shall be of cast iron or cast steel and shall be suspended from a non-corrodible shaft which will pass through a stuffing box and be connected to the cushion chamber on the outside of the valve.

E. A removable cover shall be provided for the removal of internal parts without necessitating the removal of the valve from the line. The high point of the valve shall be tapped and equipped with a plug. Valves shall be flanged with flanges dimensioned and drilled to the ANSI 125 pound standard.

2.3 AIR VALVES

A. Air valves shall be in accordance with the materials specifications and as shown on the standard details.

B. Air valves shall be 1-inch size on pipelines 12inches in diameter and smaller.

C. Air valves shall be located at all high points on the pipeline or as directed by the OWNER.

D. Air valves shall be installed in pre-cast concrete manholes.

K. A tapping saddle shall be used on all valve installation.

2.4 VALVE BOXES

A. All valves not inside structures shall be provided with cast iron valve boxes and covers. Valves boxes shall be 2-piece or 3-piece screw type with round or oval bases and 5-1/4 inch shafts. Valve box covers shall be marked "sprinkler water" unless noted otherwise.

B. Extension stems shall be provided for valves as shown on the drawings. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve. Stem couplings shall be both threaded and keyed to the coupled stems. Pipe couplings shall not be acceptable.

C. Stems shall extend to within 12-inches of the surface of the ground unless noted otherwise on the drawings. Connect each stem to the valve operator. Pin all connections. Each extension stem shall be provided with stem guides that are adjustable in two directions. Stem guides shall be cast iron, bronze bushed, and mounted on cast iron brackets. Stem guide spacing shall not exceed 5 feet.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install each valve box on a firm base at the proper elevation only after the satisfactory completion of all pressure and leak testing. The valve box shall be installed so as not to transmit any shock or stress to the valve. Carefully backfill and tamp round the valve box so that the valve box remains centered and plumb over the wrench nut of the valve. The bottom of the base section of the valve box shall be at or below the bottom of the operating nut on the valve.

B. In its final position the top of the valve box cover shall be exactly flush with any paved surface and not more than 2 inches above any ground surface.

C. Unless otherwise shown or noted, pour a 2-foot square or 2-foot diameter by 6-inch thick concrete pad around the top of all valve boxes that are not located in paved surfaces.

END OF SECTION 33 12 16

SECTION 33 31 00 – SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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 installation of asphalt paving as follows:

1. Installation of sanitary sewage gravity lines, lateral connections, and structures.

B. Related Sections:

1. Section 015000 – Temporary Facilities and Controls
2. Section 310000 – Earthwork
3. Section 311000 – Site Clearing
4. Section 312500 – Erosion and Sedimentation Controls

1.3 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's Representative.

B. Unless noted otherwise, only submit items that vary from the construction plans. Describe in the submittal why the substitution is being requested.

C.

1.4 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in accordance with the manufacturer's specifications and recommendations and also that of the utility Owner or Owner's Representative.

1.6 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials will be visually inspected by the Owner or Owner's Representative at the site for conformance to the specifications. At the Owner or Owner's Representative's discretion the Contractor may be required to supply certified mill tests, samples, or other suitable form of verification that the material meets the required specifications.

2.2 PIPE MATERIALS

A. Polyvinyl Chloride (PVC) pipe: Pipe and fittings shall meet or exceed the requirements of ASTM D3034, SDR 35 for pipe from 4" to 15" in diameter. For sizes from 18" to 27" in diameter, the pipe shall meet or exceed the requirements of ASTM F-679, wall thickness T-1. All PVC pipe shall meet the requirements of the Materials Specifications herein.

B. Ductile Iron Pipe (DIP): Pipe shall be made of good quality ductile iron in conformance with the latest revision of ANSI/AWWA C-151/A21.51 Standard. The pipe shall be push-on joint with a minimum pressure class of 150 psi, cement-lined according to ANSI 21.4/AWWA C-104, and coated inside and outside with an asphaltic coating. Ductile iron pipe and fittings shall conform to the requirements of the Materials Specifications herein.

C. Sewer laterals shall include 6-inch tees of the same material as the sewer main, which are able to withstand all test pressures without leakage.

2.3 FLEXIBLE COUPLINGS

A. Flexible couplings are designed to join sewer pipes of the same or different material or sizes. Flexible couplings shall fit over the end of plain end or spigot pipe to form a positive seal against infiltration and exfiltration in non-pressure applications. Flexible couplings shall flex with normal earth movement to maintain integrity of seal. Use of flexible couplings shall be at the Owner or Owner's Representative's discretion.

B. Flexible couplings shall be manufactured from elastomeric Polyvinyl chloride (PVC) which is unaffected by soil conditions and resistant to chemical, ultraviolet rays, and normal sewer gases. The PVC material shall contain bactericide and fungicide to inhibit growth of bacteria and fungus. The PVC material shall be 55 minimum to 65 maximum

Shore A durometer hardness. Couplings shall conform to the applicable parts of ASTM C-443, C-425, C-564, and D-1869.

C. Each flexible coupling shall be supplied with two corrosion resistant series 300 stainless steel clamps, which when tightened to 60 inch-pounds torque, seal the joint.

D. Flexible couplings shall be approved and listed by all of the following code agencies: SBCCI (southern Building Code Congress International, Inc.), BOCA (Building Officials & Code Administrators International, Inc.), IAPMO (International Association of Plumbing and Mechanical Officials), and CSA (Canadian Standards Association).

2.4 SADDLE TEES

A. Saddle tees shall consist of a gasketed skirt sized to fit the existing pipe and an integral 6-inch branch connection. The saddle shall include two stainless steel straps or a single 3-1/2" wide stainless steel strap to attach it to the existing pipe. Saddle tees shall meet the requirements of ASTM 3034 and F-477.

PART 3 - EXECUTION

3.1 GENERAL

A. Sewers shall be designed with a 10-foot horizontal separation from any existing or proposed water main. If this is not practical, the sewer may be placed closer than 10 feet to a water main, provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main, or as directed by the Owner or Owner's Representative or Owner or Owner's Representative's Representative.

B. Where a sewer crosses under a water main, the top of the sewer shall be at least 18 inches below the bottom of the water main. If the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation, or the water main shall be reconstructed with ductile iron pipe for a distance of 10 feet on each side of the sewer with a full pipe section of the water main centered over the sewer, or as directed by the Owner or Owner's Representative.

1. Minimum slope for sanitary sewers shall be as follows:

Pipe Size		Min. % Slope
6"	LATERALS ONLY	0.62%
8"		0.40%
10"		0.28%
12"		0.22%
15"		0.15%
18"		0.12%
21"		0.10%
24"		0.08%

Minimum slope for other diameters shall be such that a minimum velocity of 2 ft/sec is maintained while the pipe is flowing full.

C. Where the slope of a sewer line is in excess of 20%, the line shall be constructed of mechanical joint ductile iron pipe with concrete anchors at each joint or as specified by the Owner or Owner's Representative or Owner or Owner's Representative's Representative.

D. Minimum cover in roadways and other traffic-bearing areas is 48 inches for PVC pipe and 30 inches for ductile iron pipe. In non-traffic-bearing areas, the minimum cover is 30 inches for either type of pipe.

E. Maximum depth for standard PVC pipe is 17 feet. Depths greater than 17 feet will generally require ductile iron pipe and shall be approved by the Owner or Owner's Representative or Owner or Owner's Representative's Representative.

F. Ductile iron pipe shall be used beneath waterways which have a continuous flow of water. Concrete encasement shall be provided when joints on the ductile iron pipe are located beneath waterways, or as directed by the Owner or Owner's Representative or Owner or Owner's Representative's Representative.

G. The maximum spacing for manholes shall be 400 feet for pipe diameters of 21 inches and smaller and 500 feet for larger pipes.

H. Where the difference in the invert elevations of two sewers intersecting in a manhole is 2 feet or more, a drop manhole shall be provided.

I. When ductile iron pipe must be used on a portion of a new sewer line segment due to minimum or maximum cover, water line proximity, or waterway crossing, the entire length of sewer must be installed with ductile iron pipe. No flexible couplings will be permitted on new construction to convert to PVC between manholes.

3.2 PIPE INSTALLATION

A. All pipe shall be installed in the presence of the Owner or Owner's Representative. Do not begin the backfilling of trenches until the pipe in place has been visually inspected by the Owner or Owner's Representative. Pipe installation shall begin at the lowest elevation, unless otherwise approved by the Owner or Owner's Representative.

B. Trench bottoms that are found to be unsuitable for foundations after pipe laying operations have started shall be corrected by bringing them to exact line and grade with material approved by the Owner or Owner's Representative.

C. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipelaying shall proceed upgrade, starting at the lower

end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.

D. Excavation for bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Excavate out bell holes no more than 2 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel rests on a solid foundation as specified in the Earthwork section. Install each pipe with a close concentric joint to avoid sudden offsets or inequalities in the flow line.

E. As the work progresses thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove and, in accordance with all laws and regulations, dispose of all earth, trash, rags, and other foreign matter from its interior.

F. Install tee branches in sewer lines to serve properly each lot adjoining the sewer and at such other locations as may be designated by the Owner or Owner's Representative. If tee branches are not to be used immediately, close them with approved plugs that are held in place to prevent infiltration and withstand all test requirements.

G. For all tees that are plugged and laid in rock, blast a minimum of 6 linear feet of ditch line in the direction and to the approximate grade of the future lateral as directed by the Owner or Owner's Representative, but do not excavate the material. Furnish the Owner or Owner's Representative with a record of the exact location of each tee installed.

H. If the work consists of constructing a new sewer to replace an existing one, connect existing laterals to the new line. Laterals which have been disconnected, cut or abandoned shall be plugged and sealed with a backing block securing the plug.

I. Cleanouts will be required only for those laterals crossing a roadway. Cleanouts should be located on the property line in most cases. However, where a long lateral crosses another private property, the cleanout should be located at the road right-of-way. In that case, a 4-inch line may be installed upstream of the cleanout to the property line.

J. For new laterals to be installed on existing sewer lines larger than 6 inches in diameter, a sewer saddle as specified in Part 2 above may be used in lieu of a tee section. The saddle shall be installed on a clean-cut, properly sized hole on the existing sewer, such that a watertight connection results. The cut in the existing pipe shall be made with a hole saw which retains the coupon. Sewer saddles shall not be used on vitrified clay pipe, or any other pipe deemed unsuitable for this method by the Owner or Owner's Representative, unless approved by the Owner or Owner's Representative.

K. For new laterals to be installed on existing sewer lines 6 inches in diameter, or as required by the Owner or Owner's Representative, the existing line shall be cut and a watertight tee section shall be installed, while pumping the existing wastewater flow around the work zone. The tee section shall consist of a new tee of the same diameter as the existing pipe, with short sections of pipe on either end. The tee section shall be installed with waterproof flexible couplings on each end as specified in Part 2 above to connect the pipe to the new tee section.

L. Install new connections to existing manholes as specified in Section 02530, Manholes-Sewer. Reshape the bottom at the manhole as necessary to fit the invert of the sewer pipe.

M. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other sections of these Specifications. Any such work shall be considered incidental to the construction of sewer mains.

N. Water service connections will be repaired or replaced in accordance with the Water Service Assemblies section, by the Contractor at his expense as an incidental part of the work.

O. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.

P. Wastewater flow must be maintained in the existing sewers. Whenever pipe-laying progresses to the point where this flow must be interrupted, the Contractor shall plug the sewer upstream of the construction and provide by-pass pumping to the downstream manhole. All downstream pipes, manholes and appurtenances must be tested and acceptable to the Owner or Owner's Representative to receive wastewater flow. Discharging raw wastewater to natural waterways will not be permitted. The Contractor shall notify the Owner or Owner's Representative prior to proceeding with by-pass pumping. When working in areas where interruption of wastewater flow may occur, the Contractor shall have lines and all other equipment in readiness at the site to provide by-pass pumping. A back-up pump and hose is required. Contractor will be liable for clean-ups, fines, and any other problems that may occur. All equipment will be checked by Owner or Owner's Representative for proper working conditions.

3.3 TESTING OF GRAVITY SEWERS

A. Visual Tests

1. Prior to backfilling, the Owner or Owner's Representative shall make a visual inspection of the sewer. The visual tests shall include a check for proper grade and alignment, sufficient pipe bedding, pipe condition, and general cleanliness. The Contractor shall immediately repair all defects found by such inspection.

2. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than ½ inch on pipe 36 inches internal diameter or smaller and ¾ inch on pipe larger than 36 inches internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the Contractor's expense.

3. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100 inch develop in the pipe within one year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, ensuring proper service of sewer pipe under conditions established by the drawings, specifications, and local conditions at the site of the work.

B. Air Testing for Sewers 24 inches in Diameter and Smaller

1. The Contractor is responsible for providing all labor and equipment for air testing.

2. This recommended practice defines the proper procedures for acceptance testing of installed gravity sewer pipe using low-pressure air, to provide assurance that the pipe, as installed, is free from significant leaks. Included are requirements for equipment accuracy, safety precautions, line preparation, test method, and minimum holding times. Air test results shall be recorded on the work sheet, which is included below in paragraph E., Air Test Data Sheet.

3. Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may also be used by the installer as a presumptive test to determine the condition of the line prior to backfilling. During sewer construction, all service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged to prevent air loss that could cause an erroneous air test result. It may be necessary and is always advisable to restrain gasketed caps, plugs, or short pipe lengths with bracing stakes, clamps, and tie-rods or wire harnesses over the pipe bells.

4. Unless otherwise specified, the Contractor shall furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. No sealant shall be used in any newly installed sewer without the prior approval of the Owner or Owner's Representative. Using sealant in a sewer is not the equivalent of a sound sewer pipe. Proper structural repair work is much preferred and may be required by the Owner or Owner's Representative.

5. The Owner or Owner's Representative shall witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized. The Owner or Owner's Representative should inform the Contractor regarding acceptable methods of repair in the event one or more sections fail to pass the low-pressure air test.

6. It is extremely important and essential that all plugs be installed and braced in such a way that blowouts are prevented. As an example of the hazard, a

force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psig, and a force of 2,250 pounds is exerted on a 24-inch plug by an internal pressure of 5 psig. It must be realized that sudden expulsion of a poorly installed plug, or of a plug that is partially deflated before the pipe pressure is released, can be very dangerous. For this reason, it is recommended that every plug be positively braced against the manhole walls, and that no one be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line.

It is further recommended that no internal pressure of more than 9 psig be permitted except for leak location equipment where the plugs are firmly tied together.

Either mechanical or pneumatic plugs may be used. All plugs shall be designed to resist internal testing pressures without the aid of external bracing or blocking. However, the Contractor should internally restrain or brace the plugs to the manhole wall as an added safety precaution throughout the test.

7. All pressurizing equipment used for low-pressure air testing shall include a regulator or relief valve set no higher than 9 psig to avoid over-pressurizing and displacing temporary or permanent plugs. As an added safety precaution, the pressure in the test section should be continuously monitored to make certain that it does not at any time exceed 9 psig. (It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization.)

8. To facilitate test verification by the Owner or Owner's Representative, all air used shall pass through a single, above ground control panel. The above ground air control equipment shall include a shut-off valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psi. The continuous monitoring gauge shall be no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of +/- 0.04 psi. Two separate hoses shall be used to: (1) connect the control panel to the sealed line for introducing low-pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line. This requirement greatly diminishes any chance for over-pressurizing the line.

   If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.

9. After a manhole-to-manhole reach of pipe has been backfilled to final grade and compacted, prepared for testing, and a 24-hour waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

   It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at

both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing. It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important to high groundwater situations.

When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probable point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.

10. Low-pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig. If the groundwater table is above the sewer being tested, the air pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer, up to a maximum of 9.0 psig. After a constant pressure of 4.0 psig (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.

When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater backpressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average backpressure of any groundwater over the pipe). At a reading of 3.5 psig, timing shall commence with a stopwatch.

If the time shown for the designated pipe size and length (see paragraph D., Air Test Time Tables, below) elapses before the air pressure drops 0.5 psig, the section undergoing test shall have passed. The test may be discontinued once the prescribed time has elapsed even though the 0.5 psig drop has not occurred. If the pressure drops 0.5 psig before the appropriate time shown in Table I has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

If the section fails to meet these requirements, the Contractor shall determine at his own expense the source, or sources, of leakage, and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Owner or Owner's Representative. The extent and type of repair which may be allowed, as well as results, shall be subject to the approval of the Owner or Owner's Representative. The completed pipe installation shall then be retested and required to meet the requirements of this test.

C. Testing for Sewers Larger than 24 Inches in Diameter

1. The Contractor is responsible for providing all labor and equipment for testing.

2. Where the natural groundwater is 24 inches or more above the top of a section of pipe, the Contractor shall measure the flow of water in the pipe and the rates of seepage and infiltration. Measure the flow rate by using a calibrated weir. Leave the weir in the line until the flow rate has stabilized. The Contractor is responsible for verifying the groundwater level by providing sight gauges in manholes or digging test holes at suitable locations.

   The total seepage and infiltration of groundwater as determined by the test shall in no case exceed 50 gallons per 24 hours per inch-mile of pipe. Make infiltration tests on all sewer construction before placing the lines in service and before making any connections to other sewers. If the amount of infiltration into the sewer(s) is in excess of the maximum quantity specified above, then repair the joints, relay the sewer (if necessary), or perform other remedial construction, at the Contractor's expense, in order to reduce groundwater infiltration to within the specified limits.

   In making infiltration tests, furnish the required equipment and labor and do the necessary pumping under the direction on the Owner or Owner's Representative. Tests may be repeated until each sewer individually meets the specifications for infiltration amounts as set above.

3. Where the groundwater is not 24 inches or more above the top of the pipe section being tested, the Contractor shall perform an exfiltration test. Bulkhead the pipe below the lower manhole of the section being tested with a pneumatic plug or other device. Insert a vent pipe 48 inches long in the stopper of the upper end of that section. Then fill the lower manhole with water, or add water until there is a minimum of 4 feet over the upper end; make certain that all air is forced out through the vent tube. Measure the drop in the level of the water in the manhole due to exfiltration over a specific time, and calculate the water loss due to exfiltration. The total exfiltration shall not exceed that specified above for infiltration.

D. Air Test Time Tables

The following tables indicate the time that must elapse before the air pressure inside the pipe drops 0.5 psig. If the pressure inside the pipe drops 0.5 psig before the time has completely elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015 ft.^{3}/min.

1 Pipe Dia. (in.)	2 Min. Time (min.: sec.)	3 Length For Min. Time (ft.)	4 Time for Longer Length (sec.)	Specification Time for Length (L) Shown (min.:sec.)			
				100 ft.	150 ft.	200 ft.	250 ft.
4	1:53	597	.190 L	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50
8	3:47	298	.760 L	3:47	3:47	3:47	3:47
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06

1 Pipe Dia. (in.)	2 Min. Time (min.: sec.)	3 Length For Min. Time (ft.)	4 Time for Longer Length (sec.)	Specification Time for Length (L) Shown (min.:sec.)			
				300 ft.	350 ft.	400 ft.	450 ft.
4	1:53	597	.190 L	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	76:55	89:44	102:34	115:23

E. Air Test Data Sheet

Air test results shall be recorded on the following worksheet:

AIR TEST DATA SHEET

Owner or Owner's Representative (Name of city, district, etc.): Test
Identification of Pipe Installation (Job name, location, contract number, etc.):

Field Test Data: (To be filled in by the inspector)										
Date: Specified Maximum Pressure Drop: psig										
Identification of Pipe Material Installed:										
Pipe Under Test				Specification Time	Field Test Operations Data					
Upstream MH sta #	Downstream MH sta #	Dia. D (in.)	Length L (ft.)	Refer to UNI-B-6 (min.:sec.)	Pressure Initially Raised to (psig)	Time Allowed for Pressure to Stabilize (min.)	Start Test Pressure (psig)	Stop Test Pressure (psig)	Elapsed Time (min.:sec.)	Pass or Fail (P or F)
Inspector's Name and Title:										
Signature of Inspector:										

If a section fails, the following items should be completed: Identify section(s) that failed:
Leak (was) (was not) located. Method used:
Description of leakage found:
Description of corrective action taken:

For test results after repair refer to Test No.:	Inspector:

3.4 DEFLECTION TESTING FOR PVC PIPE

A. The Contractor is responsible for providing all labor and equipment for deflection testing.

B. Test deflection of the pipe by manually pulling with twine a one-piece 9-arm go/no-go mandrel (sized in accordance with ASTM D3034) through the pipe. Within 24 hours after compaction of the backfill is complete, the line shall be tested using a 5% deflection mandrel. If the line is satisfactory, it shall be retested using a 7.5% deflection mandrel no less than 30 days following the completion of compaction.

3.5 CLEANUP

C. After completing each section of the sewer line, all debris and construction materials shall be removed from the work site and disposed of in compliance with all applicable laws and regulations and with Section 02321, paragraph 3.4. Then the surface shall be graded and smoothed on both sides of the line. The entire area shall be left clean and in a condition satisfactory to the Owner or Owner's Representative. The Contractor shall keep cleanup operations as close to active pipe laying activities as practical, generally following by less than 300 feet, or as approved by the Owner or Owner's Representative.

END OF SECTION 33 31 00

SECTION 33 40 00 – STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Plans 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. Storm drainage pipe work including furnishing and installation of pipes, joint materials, and couplings.
2. Storm drainage structures including furnishing and installation of manholes, catch basins, area drains, and other structures incidental to the construction of storm sewers.

B. Related Sections:

1. Section 310000 – Earthwork for excavation (defined as unclassified) for pipe trenches and structures and backfill.

1.3 DEFINITIONS

A. The diameter of pipe culverts and storm drains shown on the project drawings and bid schedule are based on Manning's n-value of 0.013, pipes flowing full, and the slopes shown on the Plans and profiles. If alternative materials and types of pipe culverts and storm drains are used, alter the diameter of the pipe shown to accommodate the required flow.

B. The length of pipe as shown on the Plans is based on its in place length as measured along the centerline with no deductions for storm structures. Actual quantity of pipe may vary; supply and install the necessary quantity of pipe to construct the complete system.

1.4 SUBMITTALS

A. Submittals shall be in electronic form (via email) and shall be stamped by the Contractor. Submit to the Owner or Owner's representative.

B. Submit shop drawings for material substitutions. Do not submit shop drawings for materials that are consistent with the plans. These submittals will be marked "Not Requested for Review" and returned.

C. Results of the mandrel and deflection tests for each line of pipe.

1.5 QUALITY ASSURANCE

A. Provide and maintain a quality control system that will provide reasonable assurance that materials and construction conform to the specified requirements.

1.6 DELIVERY, STORAGE, & HANDLING

A. Delivery, storage, and handling shall be in accordance with these specifications and the manufacturer's requirements.

B. All pipe, structures, and appurtenances shall be inspected and accepted by an approved commercial testing laboratory prior to delivery to the work site. Each joint and each structure shall be stenciled or otherwise marked with the laboratory's mark of acceptance. Furnish the Engineer with a certified copy (via email) of the laboratory's report of inspection, test, and acceptance on all pipe and appurtenances prior to its incorporation in the work.

1.7 PROJECT CONDITIONS

A. Verify the locations of the existing underground utilities by contacting the utility owners and by potholing in the field.

B. Notify the utility owners prior to beginning work.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

A. Reinforced Concrete Pipe (RCP): All concrete sewer pipe with an internal diameter of 15 inches or less shall be extra strength sewer pipe conforming to ASTM C14. All concrete pipe with an internal diameter of 18 inches or more shall be Class III reinforced concrete pipe conforming to ASTM C76. Horizontal elliptical shall conform to C-507 Class HE-II, HE-III, or HE-IV as specified on the drawings.

B. Corrugated Metal Pipe (CMP): Shall conform to the requirements of AASHTO M36 specifications for corrugated metal culvert pipe or AASHTO M 196 for aluminum coated

steel pipe. Pipe diameters of 18-inches or smaller shall be 14-gauge minimum. Pipe diameters from 24-inch to 48-inch shall be 12-gauge minimum. Pipe diameters of 54-inch or greater shall be 10-gauge minimum.

C. High Density Polyethylene (HDPE) Pipe: Pipe and appurtenances shall be high density polyethylene (HDPE) conforming to the requirements of ASTM F2306/F2306M-05. The pipe shall have a smooth interior and annular-corrugated exterior.

2.2 STORM PIPE ACCESSORIES

A. Joint Materials:

1. Cement Mortar Joints: Joints shall consist of a mixture of 1 part standard portland cement, 2 parts sand, and enough water to produce a uniform mixture of proper consistency and workability that will adhere to the pipe. The cement, sand, and water shall be in conformity with the applicable provisions of Section 03301, Concrete Work. Do not use mortar that has been mixed longer than 30 minutes for making pipe joints.

2. Asphaltic Joints: Jointing compounds shall be equivalent in quality and type to GK asphaltic jointing compound. The selection by the Contractor of an asphaltic jointing compound shall be approved by the Engineer prior to the purchase or use of same. Furnish the Engineer with complete technical and construction data on the jointing compound to be approved.

3. Rubber Gasket Joints: The bell and spigot and the tongue and groove of the pipe shall be specially manufactured and prepared for the use of the type of joint selected. The rubber gaskets shall be watertight (WT) and meet the requirements of ASTM F2306, AASHTO M252, or AASHTO 294.

4. O-Ring Rubber Gasket Joints: Joints shall consist of a bell and spigot type joint with an O-ring rubber gasket that is watertight (WT) meeting the requirements of ASTM F477.

B. Couplings: Couplings shall be of the same material and as the pipe and corrugated to match the corrugations. Couplings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Use bell and spigot, split collar, or screw-on collar couplings.

2.3 STRUCTURES AND APPURTENANCES

A. Catch basins, manholes, and area drains shall be precast concrete as shown on the Plans or as otherwise directed by the Engineer. Precast concrete shall meet the applicable requirements of ASTM C478 with a minimum f'c = 4,000 psi.

B. Brick: Grade SM, ASTM C32, or concrete brick conforming to the requirements of ASTM C55, Grade N-I.

C. Grates, Frames, And Curb Castings: Conforming to the requirements of ASTM A-48, Class 30. Machining of contact surfaces will be required so that covers and grates rest securely on the frames.

D. Ladder Bars: Shall be made of aluminum alloy conforming to Federal Specification QQ-A-200/8.

E. Mortar: Shall be composed of one part Portland cement and 2 parts sand (volumetric measure). Mortar that has been mixed for more than 30 minutes which has been retempered or which has "set" shall not be used in the work.

F. Headwalls and End Sections: Shall be precast concrete as shown on the Plans or as otherwise directed by the Engineer.

PART 3 - EXECUTION

3.1 PIPELINE CONSTRUCTION

A. Carefully protect all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work from damage at all times. Wherever it is necessary for the proper accomplishment of the work to repair, remove, and/or replace any utility or structure, do so in accordance with the provisions set forth in the General and Supplementary Conditions.

B. Before constructing or placing joints, demonstrate to the Engineer, by completing at least one sample joint, that the methods employed conform to the specifications and will provide a watertight joint, and further that the workmen intended for use on this phase of the work are thoroughly familiar and experienced with the type of joint proposed.

C. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as provided in the Earthwork section.

D. Wherever necessary to provide a satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the Engineer. Cradles shall be of concrete with f'c = 4,000 psi, as defined by ACI standards, and shall conform to the dimensions shown on the detailed Plans.

E. Tightly stretch a mason's line or wire above the ground level, parallel to and directly above the axis of the pipe to be installed; this line is to be supported at intervals of no more than 50 feet on sewers being laid on a grade of 2% or more and not exceeding 25 feet for grades of less than 2%. Determine the exact line and grade for each section of

pipe by measuring down from this line to the invert of the pipe in place. Accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter boards. The use of laser beams will be allowed.

F. Do not allow water to run or stand in the trench while pipe laying is in progress, before the joint has completely set, or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.

G. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have been started, and bring them to exact line and grade with compacted earth as necessary.

H. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade.

I. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut bell holes out not more than 10 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel will rest on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

J. Jointing operations shall follow pipe laying very closely; failure to comply with this provision will result in the Engineer stopping all pipe laying operations until jointing operations catch up.

K. After the joints have been completed, they shall be inspected, tested, and accepted by the Engineer before they can be covered. The pipe shall meet test requirements for watertightness; immediately repair any leaks or defects discovered at any time after completion of the work. Take up any pipe that has been disturbed after joints were formed; clean and remake the joints; and relay the pipe at the Contractor's expense. Carefully protect all pipe in place from damage until backfill operations are completed.

L. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the Engineer. Backfilling shall be performed in accordance with the requirements provided in the Earthwork section.

M. As the work progresses, thoroughly clean the interior of all pipe in place. On small pipe, keep a swab or drag in the pipeline, and pull forward past each joint immediately after it has been made. After laying each line of pipe, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.

3.2 JOINT CONSTRUCTION

A. Cement Mortar Joints: Roll a gasket of jute or oakum thick enough to fill completely the annular space between the bell of one pipe and the spigot of another. This gasket shall be thoroughly saturated in a cement grout composed of neat portland cement and clean water mixed to the heaviest fluid consistency that will thoroughly impregnate gasket material to the Engineer's satisfaction. Then lay the gasket in the bell in the lower 1/3 of the circumference of the joint, and cover with mortar. Insert the spigot of the pipe, and carefully drive home; then insert a small amount of mortar into the annular space around the entire circumference of the pipe.

B. Wrap the ends of the gasket around one pipe, and solidly ram into the joint with a caulking tool. The depth of caulking shall be such as will leave a space of approximately 1-1/2 inches in pipe 18 inches and less in diameter or of 2-1/4 inches in pipe 21 inches and larger in diameter, measured from the end of the bell. Drive the mortar previously placed ahead of the gasket. Then fill the joints with Portland cement mortar. This mortar must be placed by hand; take care to fill the joint completely entirely around the pipe by pushing the mortar in by hand, using a rubber glove with fingers and a wooden caulking tool. Bevel the joints off at an angle of 45 degrees with the outside of the pipe, and protect with a wetted strip of muslin placed completely around the joint.

C. Make joints in tongue and groove pipe with cement mortar in the manner specified above for bell and spigot pipe, except that the gasket material shall be omitted and both the outside and inside surfaces of the joints shall be wiped smooth. When modified tongue and groove pipe is used, bevel the joints off at an angle of 45 degrees with the outside of the pipe, and protect with muslin as specified above for bell and spigot pipe.

D. Asphaltic Joints: Install asphaltic joints in accordance with the manufacturer's recommendations and specifications in respect to heating, pouring, and joint construction. When asphaltic jointing compound is used, alternate joints may be poured before the 2 sections are lowered into the trench. In such cases, the joint must be allowed to set before placing and the bottom of the trench carefully graded to provide uniform bearing after the pipes are placed in final position.

E. Rubber Joints: Rubber gaskets and the method of joint construction shall form a flexible watertight seal and shall be in strict compliance with the manufacturer's directions and requirements. Adequately lubricate the gaskets with special cement provided for this purpose. Pipe joints shall be adequately and thoroughly driven home or seated.

F. O-Ring Rubber Gasket Joints: O-ring rubber gasket joints shall be placed on the spigot end at least two corrugations of the spigot must insert into the bell end.

G. Couplings: Install couplings in accordance with the manufacturer’s specifications. Split collar couplings shall engage at least two full corrugations on each pipe section and screw-on collars shall be in width at least one-half the nominal diameter of the pipe.

3.3 WYES AND TEES

A. Install wyes and tee branches in the sewer line as shown on the drawings and/or at such other locations as may be designated by the Engineer. If such branches are not to be used immediately, close them with manufacturer approved stoppers.

3.4 CONNECTIONS

A. Make connections to all existing sewer lines as shown on the Plans or as directed by the Engineer. Make connections either by removing a section of the sewer from the existing line and inserting in the space a wye branch of the proper size or by constructing a manhole, junction box, regulator chamber, or other structure as shown on the Plans.

B. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of pipe into the hole, filling around the pipe with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish. Shape or reshape the bottoms of manholes as necessary to fit the invert of the sewer pipe.

3.5 PIPE PROTECTION

A. Construction loads may exceed design loads. These heavy loads can cause damage if construction equipment crosses over the installed pipe before adequate fill has been placed or moves too close to the trench walls, creating unbalanced loadings. Provide additional protective fill or other appropriate protection at equipment crossings.

B. If pipe sewer has less than 1-1/2 feet of cover when completed, provide concrete protection as shown on the drawings or required by the Engineer. Place the protection in accordance with the Plans.

3.6 INSTALLATION OF STRUCTURES AND APPURTENANCES

A. Construct inlets to the sizes, shapes, and dimensions shown on the drawings or as directed by the Engineer to meet special conditions. Excavate for structures in accordance with the applicable provisions of the Earthwork section.

B. Where inlets are to be constructed in existing pavements and/or curbs and gutters, cut such pavements and/or curbs and gutters to a neat line with an air hammer or other suitable equipment, removing no more pavement and/or curb and gutter than is essential.

C. Protect inlet foundations from damage by water and/or other causes. Place no concrete until the trench has been freed from water and/or mud, and maintain the trench in a reasonably dry condition during the progress of construction on structures.

D. When the foundation has been prepared and is approved by the Engineer, construct the bottom to the required line and grade. After the bottom has been allowed to set for a period of no less than 24 hours, construct the inlet thereon, taking care to form the pipe or pipes into the walls at the required elevations.

E. Lay brick in common bond with joints staggered from course to course. All joints at the face of wall shall be no more than 1/2 inch thick and shall be trowel struck joints to provide a clean, smooth wall surface. Wet each brick thoroughly by immersing it in water immediately before placement; lay each brick separately in a full and close joint of mortar on its bed, sides, and/or ends in one operation by shoving the brick into the mortar. Make no joints by working mortar into the joints, by grouting, or by "slushing" after the brick is in place. Brick work shall be plumb and in conformance with the drawing dimensions.

F. Whenever work is discontinued for any purpose, rack the unfinished brick masonry back into courses, and remove all mortar from exposed surfaces. When work is resumed, clean and thoroughly wet the exposed surfaces before adding any new work.

G. Carefully protect fresh brickwork against damage from freezing and against movement from any cause. Remove and properly rebuild any work that, in the opinion of the Engineer has been damaged by any cause either before or after backfilling.

H. Set all castings accurately to line and grade in full cement mortar beds on the brick masonry. Unless otherwise shown on the Plans and/or directed by the Engineer, set all grate frames no less than 1 inch below the normal grade of surrounding pavement and no less than 3 inches below the normal surface of unpaved areas; then slope the surrounding area to the grates on an approximate slope of 12:1. Mount frame in grout, secured to the top cone section to the elevation as indicated on the Plans.

I. After the masonry and frames have time to set, but in no case less than 24 hours, the space around the drainage structure shall be backfilled and compacted to the required grade and as specified in the Earthwork section.

J. Install headwalls and/or end sections as shown on the Plans and in accordance with the manufacturer's specifications.

3.7 FIELD QUALITY CONTROL

A. After backfilling and the embankment are complete and prior to placing the base, the contractor shall perform deflection and alignment tests on each line of pipe. For pipe diameters of less than 30-inches, deflection testing shall be performed using a 9-vane mandrel with a diameter that is 5% less than the nominal diameter of the pipe being tested. The mandrel vanes shall be equally spaced around the central core. At the Contractor's expense, replace any line of pipe through which the mandrel does not freely pass.

B. For pipe diameters 30-inches or greater, deflection shall be tested as described above or may be checked by other means as approved by the Engineer. Pipe with a deflection of 5% or greater of the nominal pipe diameter or with undue misalignment shall be replaced at the contractor's expense.

C. After backfill has been placed and compacted to a depth not less than one foot above top of pipe, a visual inspection shall be made by flashing a light between manholes. Any displacement or misalignment of invert shall be corrected.

D. Install drainage structures and pipes to the line, grade, and cross-section as shown on the Plans and with finish elevation not more than 0.04' above or below the required elevation.

3.8 CLEANUP AND PROTECTION

A. After completing each section of storm drainage line, remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

B. The interior of catch basins, area drains, and manholes shall be cleaned of debris and excess material, the grating or cover placed, and all unused material, equipment, tools, and debris removed from the area.

END OF SECTION 33 40 00