PROJECT MANUAL FOR:

BEVERLY MIDDLE SCHOOL

502 CABOT STREET • BEVERLY, MASSACHUSETTS

100% Design Development

Not for Construction

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Volume 2 of 2

TABLE OF CONTENTS

VOLUME 1 *(DIVISIONS 00 THROUGH DIVISION 14)*

DIVISION 00 — PROCUREMENT AND CONTRACTING REQUIREMENTS
Document 00 01 01 Project Title Page
Document 00 01 02 Project Directory
Document 00 01 10 Table of Contents
Document 00 62 12 Product Submittal Form
Document 00 63 13 Request For Interpretation (RFI) Form
Document 00 63 25 Substitution Request Form

DIVISION 01 — GENERAL REQUIREMENTS
Section 01 10 00 Summary
Section 01 25 13 Product Substitution Procedures
Section 01 29 00 Payment Procedures
Section 01 31 00 Project Management and Coordination
Section 01 32 00 Construction Progress Documentation
Section 01 33 00 Submittal Procedures
Section 01 35 43 Environmental Procedures
Section 01 41 00 Regulatory Requirements
Section 01 41 17 Utilities Notification
Section 01 42 00 References
Section 01 45 00 Quality Control
Section 01 45 23 Testing and Inspecting Services
Section 01 45 29 Testing Laboratory Services
Section 01 50 00 Temporary Facilities and Controls
Section 01 56 39 Tree Protection and Trimming
Section 01 60 00 Product Requirements
Section 01 73 00 Execution
Section 01 77 00 Closeout Procedures
Section 01 78 00 Closeout Submittals
Section 01 78 36 Warranties
Section 01 81 19 Indoor Air Quality Requirements

DIVISION 02 — EXISTING CONDITIONS
Section 02 28 20 Asbestos Remediation
Section 02 30 00 Subsurface Investigation
Section 02 41 00 Site Demolition
Section 02 41 17 Building Demolition
Section 02 95 00 As-Built Site Survey

DIVISION 03 — CONCRETE
Section 03 05 13 Concrete Sealers
Section 03 30 00 Cast-in-Place Concrete

DIVISION 04 — MASONRY
Section 04 20 00 * Unit Masonry
(Trade Contract Required)
Section 04 43 10 Granite Cut Stone
Section 04 43 20 Stone Masonry
Section 04 73 16 * Simulated Stone Veneer
(Trade Contract Required)

DIVISION 05 — METALS
Section 05 12 00 Structural Steel Framing
Section 05 15 00 Stud Shear Connectors
Section 05 21 00 Steel Joist Framing
Section 05 31 00 Steel Decking
Section 05 40 00 Cold-Formed Metal Framing
Section 05 50 00 Metal Fabrications
(Filed Sub-Bid Required)
Section 05 51 00 Metal Stairs and Railings
(Filed Sub-Bid Required)
Section 05 58 13 Column Covers

DIVISION 06 — WOOD, PLASTICS AND COMPOSITES
Section 06 10 00 Rough Carpentry
Section 06 15 00 Wood Decking
Section 06 16 00 Sheathing
Section 06 20 00 Finish Carpentry
Section 06 40 00 Architectural Woodwork
Section 06 55 00 Solid Surfacing

DIVISION 07 — THERMAL AND MOISTURE PROTECTION
Section 07 13 53 * Elastomeric Sheet Waterproofing
(Trade Contract Required)
Section 07 16 13 * Polymer Modified Cement Waterproofing
(Trade Contract Required)
Section 07 21 00 Thermal Insulation
Section 07 24 20 Exterior Finish System (EFS)
Section 07 26 00 Vapor Retarders
Section 07 27 13 * Modified Bituminous Sheet Air Barriers
Section 07 27 33 Closed-Cell Sprayed Foam Insulation
Section 07 46 46 Fiber Cement Siding
Section 07 54 19 * Polyvinyl Chloride (PVC) Roofing
(Trade Contract Required)
Section 07 62 00 * Sheet Metal Flashing and Trim
(Trade Contract Required)
Section 07 71 00 * Roof Specialties
(Trade Contract Required)
Section 07 72 00 * Roof Accessories
(Trade Contract Required)
Section 07 81 00 Applied Fireproofing
Section 07 84 00 Firestopping
Section 07 92 00 * Joint Sealants
(Trade Contract Required)
Section 07 95 13 Construction and Expansion Joints

DIVISION 08 — OPENINGS
Section 08 11 13 Hollow Metal Doors and Frames
Section 08 14 16 Flush Wood Doors
Section 08 31 00 Access Doors and Panels
Section 08 33 13 Coiling Counter Doors
Section 08 33 23 Overhead Coiling Doors
Section 08 33 26 Overhead Coiling Grilles
Section 08 34 73 Sound Control Doors

Section 08 43 13 * Aluminum-Framed Storefronts
(Trade Contract Required)
Section 08 44 13 * Glazed Aluminum Curtain Walls
(Trade Contract Required)
Section 08 51 13 * Aluminum Windows
(Trade Contract Required)
Section 08 80 00 * Glazing
(Trade Contract Required)
Section 08 87 00 * Glazing Surface Film
(Trade Contract Required)
Section 08 90 00 Louvers and Vents
Section 08 92 00 Louvered Equipment Enclosures

DIVISION 09 — FINISHES
Section 09 05 06 * Common Work Results for Flooring
(Trade Contract Required)
Section 09 21 23 Shaft Wall Assemblies
Section 09 22 16 Non-Structural Metal Framing
Section 09 29 00 Gypsum Board
Section 09 30 13 * Ceramic Tiling
(Trade Contract Required)
Section 09 30 16 * Quarry Tiling
(Trade Contract Required)
Section 09 30 19 * Paver Tiling
(Trade Contract Required)
Section 09 51 00 * Acoustical Ceilings
(Trade Contract Required)
Section 09 64 29 Wood Strip and Plank Flooring
Section 09 64 66 Wood Athletic Flooring
Section 09 65 13 * Resilient Base and Accessories
(Trade Contract Required)
Section 09 65 16 * Resilient Sheet Flooring
(Trade Contract Required)
Section 09 65 19 * Resilient Tile Flooring
(Trade Contract Required)
Section 09 65 23 * Rubber Flooring
(Trade Contract Required)
Section 09 65 36 * Static-Control Resilient Flooring
(Trade Contract Required)
Section 09 65 43 * Linoleum Flooring
(Trade Contract Required)
Section 09 66 23 Resinous Matrix Terrazzo Flooring
(Trade Contract Required)
Section 09 68 00 Carpeting
Section 09 72 00 Wall Coverings
Section 09 84 00 Acoustic Room Components
Section 09 91 00 * Painting
(Trade Contract Required)
Section 09 96 00 * High-Performance Coatings
(Trade Contract Required)

DIVISION 10 — SPECIALTIES
Section 10 11 16 Markerboards
Section 10 12 00 Display Cases
Section 10 14 00 Signage
Section 10 21 13 Toilet Compartments

Section 10 22 15 Fixed Glass Panel Partitions
(Trade Contract Required)
Section 10 22 26 Operable Glass Partitions
(Trade Contract Required)
Section 10 22 28 Folding-Panel Partitions
Section 10 28 13 Toilet Accessories
Section 10 44 00 Fire Protection Specialties
Section 10 51 13 Metal Lockers
Section 10 71 13 * Exterior Sun Control Devices
(Trade Contract Required)

DIVISION 11 — EQUIPMENT
Section 11 13 00 Loading Dock Equipment
Section 11 31 00 Appliances
Section 11 40 00 Foodservice Equipment
Section 11 52 13 Projection Screens
Section 11 53 00 Laboratory Equipment
Section 11 57 00 Vocational Shop Equipment
Section 11 66 23 Gymnasium Equipment
Section 11 66 24 Basketball Equipment
Section 11 66 53 Gymnasium Dividers
Section 11 68 00 Play Field Equipment and Structures

DIVISION 12 — FURNISHINGS
Section 12 24 00 Window Shades
Section 12 30 00 Casework
Section 12 35 51 Musical Instrument Storage Casework
Section 12 48 13 Entrance Floor Mats and Frames
Section 12 61 00 Fixed Audience Seating
Section 12 66 13 Telescoping Bleachers
Section 12 68 00 Seat and Table Systems
Section 12 93 00 Site Furnishings

DIVISION 14 — CONVEYING SYSTEMS
Section 14 22 00 * Compact Traction Elevators
(Trade Contract Required)

VOLUME 2 ***(DIVISIONS 21 THROUGH 33 + APPENDICES)***

DIVISION 21 — FIRE SUPPRESSION
Section 21 00 00 * Fire Suppression
(Trade Contract Required)

DIVISION 22 — PLUMBING
Section 22 00 00 * Plumbing
(Trade Contract Required)

DIVISION 23 — HEATING, VENTILATING AND AIR CONDITIONING
Section 23 00 00 * Heating, Ventilation and Air Conditioning
(Trade Contract Required)

DIVISION 26 — ELECTRICAL
Section 26 00 00 * Electrical
(Trade Contract Required)

DIVISION 27 — COMMUNICATIONS
Section 27 10 00 Structured Cabling
(Trade Contract Required)
Section 27 21 33 Data Communications Wireless Access Points
(Trade Contract Required)
Section 27 40 00 Audio-Video Communications
(Trade Contract Required)
Section 27 50 00 Distributed Communications and Monitoring
(Trade Contract Required)
Section 27 70 00 Video Distribution System
(Trade Contract Required)

DIVISION 28 — ELECTRONIC SAFETY AND SECURITY
Section 28 00 00 * Electronic Safety and Security
(Trade Contract Required)

DIVISION 31 — EARTHWORK
Section 31 00 00 Earthwork
Section 31 10 00 Site Preparation and Cleaning
Section 31 23 19 Dewatering and Drainage
Section 31 25 00 Erosion Control

DIVISION 32 — EXTERIOR IMPROVEMENTS
Section 32 00 00 Bituminous Concrete Pavement, Curbing and Edging
Section 32 13 13 Site Concrete
Section 32 14 00 Unit Pavers
Section 32 17 23 Pavement Markings
Section 32 17 24 Signs
Section 32 31 14 Black Vinyl Chain Link Fencing and Gates
Section 32 31 20 Green Trellis Fence
Section 32 32 00 Segmental Retaining Wall
Section 32 32 10 Boulder Placement
Section 32 50 00 Stormwater Pollution Prevention Plan
Section 32 84 00 Irrigation
Section 32 92 00 Soil Preparation for Lawn Establishment
Section 32 92 10 Soil Preparation for Athletic Fields
Section 32 92 20 Seeding for Lawn Areas
Section 32 92 30 Sodding
Section 32 92 40 Seeding for Non-Lawn Areas
Section 32 92 50 Soil Preparation for Rain Gardens
Section 32 93 10 Trees, Shrubs, and Groundcovers

DIVISION 33 — UTILITIES
Section 33 05 13 Drainage Manholes and Catch Basins
Section 33 10 00 Water Distribution
Section 33 30 01 Sanitary Sewerage
Section 33 40 00 Storm Drainage Systems

APPENDICES

Appendix A Keynote List

End - Table of Contents

SECTION 21 00 00
FIRE SUPPRESSION

(Filed Sub-Bid Required)

INDEX

SECTION 21 00 00 1
PART 1 GENERAL 1
1.1 GENERAL PROVISIONS 1
1.2 GENERAL REFERENCES 2
1.3 SCOPE OF WORK 2
1.4 WORK NOT INCLUDED 3
1.5 INTENT 3
1.6 CODES, REGULATIONS AND STANDARDS 3
1.7 DRAWINGS AND CONFLICTS IN THE WORK 4
1.8 EXCHANGE OF INFORMATION AND COORDINATION 4
1.9 WORKMANSHIP 4
1.10 SITE INVESTIGATION 5
1.11 TAXES AND INSURANCE 5
1.12 PERMITS AND INSPECTIONS 5
1.13 CONTRACT COST BREAKDOWN 5
1.14 GUARANTEE 5
1.15 MATERIALS 6
1.16 MATERIALS AND EQUIPMENT HANDLING 6
1.17 MAINTENANCE AND PROTECTION OF MATERIALS 6
1.18 SHOP DRAWINGS AND MATERIAL SCHEDULE 7
1.19 RECORD DRAWINGS 7
1.20 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS 8
1.21 COORDINATION DRAWINGS 8
1.22 CLEANING OF SYSTEMS 8
1.23 RUBBISH REMOVAL 8
1.24 TEMPORARY STRUCTURES 9
1.25 TEMPORARY SERVICES 9
1.26 TESTS 9
1.27 EQUIPMENT ACCESS REQUIREMENTS 9
1.28 MOTOR CHARACTERISTICS 9
1.29 WIRING DIAGRAMS 10
1.30 PROCEDURE FOR TESTING 10
PART 2 PRODUCTS 11
2.1 INSTALLATION REQUIREMENTS 11
2.2 ACCESS PANELS 11
2.3 PIPE AND FITTINGS 11
2.4 VALVES 12
2.5 HANGERS, SUPPORTS AND SEISMIC RESTRAINTS 12
2.6 SLEEVES AND INSERTS 14
2.7 ESCUTCHEONS 14
2.8 SPRINKLER HEADS 15
2.9 SPARE SPRINKLER HEADS AND CABINETS 15
2.10 ALARM CHECK VALVE 15
2.11 BACKFLOW PREVENTER 16
2.12 FIRE VALVE CABINETS 16
2.13 FIRE DEPARTMENT CONNECTIONS & INDICATER VALVE 16
2.14 DRAINS AND TEST CONNECTIONS 16
2.15 FIRE PROTECTION ALARMS 16

2.16 SYSTEM DIAGRAM 17
PART 3 EXECUTION 17
3.1 OPERATION AND START-UP 17
3.2 COORDINATION 17
3.3 PAINTING 18
3.4 WORKING PLANS, FLOW TEST AND HYDRAULIC CALCULATIONS 18

SECTION 21 00 00
FIRE SUPPRESSION
(Filed Sub-Bid Required)

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS shall be included in, and made a part of this Section.

B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:

Civil Work Drawings: C0.1 through C0 inclusive.
Architectural Drawings: A1.01 through A1 inclusive.
Food Service Drawings: K1.0 through K1 inclusive
Structural Drawings: S0. through S inclusive.
Plumbing Drawings: P0.1 through P2.1 inclusive.
Fire Protection Drawings: FP0.1 through FP2.1 inclusive.
Mechanical Drawings: M0.1 through M inclusive
Electrical Drawings: E through E inclusive.
Telecommunications Drawings: T through T inclusive

1. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
2. Refer to Section 01 23 00 - ALTERNATES, for alternates that may affect the scope of Work of this Section.

D. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____
SUB-BID FOR TRADE: TITLE.

2. Each Sub-Bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid deposit in compliance with MGL c149, Section 44B in the amount of 5 percent of Filed Sub-Bid.

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Contract for Construction Services and Division 1, General Requirements are hereby made a part of this Section.

B. Examine all Drawings and all other sections of the specifications for requirements therein affecting the work of this section.

1.3 SCOPE OF WORK

A. Work in this Section includes all labor, materials, equipment and services necessary to furnish completely and install all FIRE SUPPRESSION SYSTEMS, as indicated on the Drawings and specified herein and, in general, as follows:
   1. Complete combined wet (manual) pipe standpipe/sprinkler systems covering all areas of the building, complete with standpipes with hose valves.
   2. Monitor, pressure and flow switches.
   3. Valve tags, valve charts, nameplates, and pipe identification and record drawings.
   4. Testing and guarantees.
   5. All hangers, inserts, sleeves, anchors, guides, strainers, gauges, thermometers, plus all related accessories required for a complete installation for each system, as specified herein and/or indicated on the drawings.
   6. All operating and maintenance manuals, certification letters and Certificates of Approval.
   7. All supplementary steel for piping and equipment supports.
   8. Working drawings of the actual fire suppression system installation, hydraulic calculations and performing of flow tests if required by local fire department.
   9. Tamper switches to be installed with supervisory signal.
   10. Supervised low pressure alarm on city side of the double check valve assembly, trouble signal upon activation.
   11. Low pressure alarm located on system side of wet system, alarm signal upon activation flow test, time to alarm 60 seconds or less desired.
   12. Hydraulic charts & signage on all valves, drains, inspector's test.
   13. Valves located above suspended ceiling shall be installed within 2 feet of the ceiling tiles for accessibility by 6 foot step later.
   14. FDC shall be 4 inch Storz type with strainer screen of 1/4inch mesh and 30 degree elbow downward, no less than 24 inches from finish grade.

B. Items to be Furnished Only: Furnish the following items for installation by the designated Sections:
   1. Access Panels
      a. Access panels for access to fire suppression equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

C. The Fire Suppression Contractor shall be responsible for all cutting related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade effected.

1. For coordination of cutting and patching, refer to Section 013100 PROJECT MANAGEMENT AND COORDINATION.

2. For cutting and patching specifications, refer to Section 017300, EXECUTION.

D. The work of this Section is shown on Drawings numbered

1.4 WORK NOT INCLUDED

A. The following related work shall be performed by the designated trades and under the listed SECTION:
1. Wiring of equipment requiring power connections and furnished by the Fire Suppression Contractor and starting devices for all motors incidental to the Fire Suppression Systems shall be furnished and installed by the Electrical Sub Contractor: Section 260000.
2. Painting of piping, fittings, coverings, hangers, supports and all equipment not specifically specified to be painted by the Painting Contractor: Section 099100
3. Electricity and water for all tests and temporary operation of Fire Suppression Systems: GENERAL REQUIREMENTS.
4. Fire water service into building to be furnished and installed by the General Contractor, SECTION 331000
5. Refer to Section 053100 Steel Decking for restrictions on hanging of materials, piping mounts, brackets, hangers, hooks and other items from the metal decking.

1.5 INTENT

A. All work shall be in accordance with the arrangement, details and locations, as indicated on the Contract Drawings, Reference Drawings and any supplemental addenda, bulletins or drawings issued by the Architect. Layouts are diagrammatic and final arrangement of equipment shall suit field conditions. Install all necessary fittings and equipment offsets required to meet job conditions. The Drawings are not intended to be scaled, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations. Work installed in a manner contrary to that shown on the Drawings, or interfering with the work of another trade, shall be removed and reinstalled when so directed by the Architect. Discrepancies and questionable points shall be immediately reported to the Architect for clarification.

1.6 CODES, REGULATIONS AND STANDARDS

A. All work shall be installed in conformance to the governing Codes, Regulations and Ordinances. It shall be the responsibility of this Contractor to familiarize himself with all governing Codes, Regulations and ordinances and report any non-compliance of the Plans and Specifications to the Architect, prior to entering into a contract. All the above requirements shall take precedence over the Plans and Specifications. These requirements are minimum criteria and no reductions permitted by Code will be allowed without written permission of the Architect.

B. All workmanship, methods and materials shall meet the highest standards of the trade and, in general, shall conform to the standards of the following associations:

American National Standards Institute (ANSI)
American Society of Mechanical Engineers (ASME)
National Board of Fire Underwriters (NBFU)

National Fire Protection Association (NFPA)
National Electrical Manufacturers Association (NEMA)
Occupational Safety and Health Act (OSHA)
Underwriters' Laboratories (U.L.)
American Society of Testing Materials (ASTM)
Massachusetts State Building Code, NFPA 1
Regulations and Ordinances of the Town of Beverly.

1.7 DRAWINGS AND CONFLICTS IN THE WORK

A. The Drawings and Specifications are intended to be complementary. Any materials shown or specified in one, but not in the other, reasonably implied and usually included under good industry practice and/or required by applicable Codes and Regulations for the proper and safe completion and operation of the work described herein, shall be furnished and installed by this Contractor at no additional cost to the Owner. Drawings show general arrangement of equipment and are not intended to indicate the exact dimensions of runs.

1.8 EXCHANGE OF INFORMATION AND COORDINATION

A. All systems and equipment covered by this Section of the Specifications shall not be installed in congested and problem areas without first coordinating the installation of same with the other trades and the General Contractor. This Contractor shall, at his own expense, relocate all equipment installed in congested or problem areas should they interfere with the proper installation of the equipment to be installed by other trades and by the General Contractor.

B. Particular attention shall be directed to the coordination of Systems with all equipment of other trades installed in the ceiling areas. Coordinate, with the other trades, the elevations of all equipment in ceiling areas to insure adequate space for the installation of fixtures before said equipment is installed.

C. Furnish to the General Contractor and all other Contractors all information relative to the portion of the installation specified in this Section that will affect them, sufficiently in advance, so that they may plan their work and installations accordingly.

D. In the case of failure on the part of this Contractor to give proper information, as indicated above, sufficiently in advance, this Contractor will pay for all back charges incurred by the General Contractor and other Contractors for the modification and/or relocation of any portion of the work already performed by them in conjunction with this Contract due to this Contractor's delay or for having given incorrect information.

E. Obtain from the other trades, all information relative to the work covered by this Section of the Specifications, which this Contractor is to execute in conjunction with the installation of their respective equipment.

F. In the event that conflicts, if any, cannot be settled rapidly and amicably between the affected trades with work proceeding in a workmanlike manner, then the Architect shall decide which work is to be relocated and his judgment shall be final and binding.

1.9 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished, in every respect, in a workmanlike and substantial manner. It is not intended that the Drawings show every detail, but this Contractor shall furnish and install all such parts as may be necessary to complete the work in accordance with the best trade practice and to the satisfaction of the Architect and the Owner. The Owner shall have the right to reject any part of the work in case the workmanship is not of satisfactory quality and this Contractor shall replace same with acceptable work at his own expense.

1.10 SITE INVESTIGATION

A. It shall be the responsibility of the Bidders to acquaint themselves with the available information, before submitting their bid. Bidders must visit the site and acquaint themselves with the existing conditions and shall study all Architectural, Structural, Mechanical and Electrical Drawings, as well as the Specifications. The Bidders shall fully inform themselves of all local and state Code requirements. Extra compensation will not be given for obvious conflictions apparent at the time of the start of the project.

1.11 TAXES AND INSURANCE

A. This Contractor shall include in his bid, applicable federal, state and local taxes and the premiums of the insurance required by the General Conditions of the Contract. This Project is exempt from Massachusetts State Sales Tax. Tax exemption number will be given to the successful bidder.

1.12 PERMITS AND INSPECTIONS

A. This Contractor shall obtain all the permits required for this Section of the work. He shall also obtain all the inspections and tests required. Defects discovered in work, materials and/or equipment shall be replaced at no cost to the Owner, and the inspection and test shall be repeated. When work is completed, this Contractor shall furnish a Certificate of Inspection and Approval, to the Owner, before final payment of the Contract will be allowed. Permits to be secured through the Town of Beverly.

B. Refer to Instructions to Bidders and General Conditions Contract for Construction Services.

1.13 CONTRACT COST BREAKDOWN

A. At the start of construction, submit a breakdown of material and labor costs to aid the Architect in determining the value of the work installed, as the job progresses. The
cost breakdown shall itemize categories of materials or portions of systems, as may be the case, to place a value on the work as it is installed.

B. No requisitions will be paid until after the breakdown is delivered to the Architect.

1.14 GUARANTEE

A. Unless otherwise noted, all materials, items of equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in material and workmanship for a period of not less than one (1) year from the date of final acceptance of the work. Any fault due to defective or improper material or workmanship which may develop within that period, shall be made good, forthwith, by and at the expense of this Contractor, including all other damage done to areas,

materials and other systems resulting from this failure.

B. This Contractor shall guarantee that all elements of the Systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

C. Upon receipt of notice from the Owner of failure of any part of the Systems during the guarantee period, the affected part or parts shall be promptly replaced by this Contractor, at no charge to the Owner.

D. This Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.15 MATERIALS

A. Materials shall be the best of their respective kinds and in full accord with the most modern mechanical construction. All materials shall be new.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed under this Contract, whether or not specifically shown on the Drawings or specified herein.

C. It is the intent of the Specifications that one manufacturer be selected, not a combination, for any particular classification of materials.

D. Where materials, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish the standard of desired quality and style and shall be the basis of the bid.

1.16 MATERIALS AND EQUIPMENT HANDLING

A. This Contractor shall do all handling of his materials and equipment and the resulting cleanup, at his expense, in a safe and satisfactory manner. Special attention shall be paid to the protection of life and property and the equipment or apparatus handled, and any corresponding damages shall be replaced, repaired or paid for by this Contractor, reviewed by the Architect. This Contractor shall provide all rigging, hoisting and staging required to complete the work of this Section, unless specifically noted otherwise.

1.17 MAINTENANCE AND PROTECTION OF MATERIALS

A. This Contractor shall be responsible for the maintenance and protection, from loss or damage of all causes, of all equipment, materials and tools supplied by him and stored or installed on the job site, until final acceptance of the project by the Owner.

B. This Contractor shall store his materials and equipment in the location designated by the Owner and maintain the storage area in a safe condition.

C. This Contractor shall clean, patch and repair any material and finishes of the building or its contents damaged during the execution of this Contract.

1.18 SHOP DRAWINGS AND MATERIAL SCHEDULE

A. Submit complete Shop Drawings in accordance with provisions of the General Conditions and of the Supplementary General Conditions.

B. Within 30 days after the date of Notice to Proceed and before purchasing any materials or equipment, submit to the Architect for approval, a complete list of the names of manufacturers of all equipment proposed to fulfill the work of this Section. After the list has been processed by the Architect, submit complete Shop Drawings of all equipment and materials. Do not order any material or equipment until approval has been obtained from the Architect.

C. The approval of equipment and materials does not relieve this Contractor from the responsibility of Shop Drawings errors in details, sizes, quantities and dimensions which deviate from the Specifications, Contract Drawings and/or job conditions as they exist.

D. If apparatus or materials are substituted by this Contractor for those specified, and such substitution necessitates changes in any mechanical or electrical equipment, or alteration to connections, piping, supports, or construction, same shall be provided. This Contractor is to assume the cost and entire responsibility thereof. The Architect's permission to make such a substitution shall not relieve this Contractor from full responsibility for the work.

E. Changes to work already performed, made necessary by delays in Shop Drawing approvals, and are the responsibility of this Contractor.

1.19 RECORD DRAWINGS

A. The Architect will provide two (2) sets of black or blue line on white drawings to the General Contractor for the purpose of maintaining record drawings, one set of which shall be maintained at the site and on which, at all times, shall be accurately, clearly and completely show the actual installation of all work of this SECTION. At the completion of the contract, this Contractor shall submit to the General Contractor a complete set of record drawings showing all "As Built" conditions. After checking the aforementioned drawings, the General Contractor shall certify that they are complete and correct and shall submit the record drawings to the Architect. The Architect may have his Consulting Engineers review the drawings to determine if the installations, as shown thereon, are complete and accurate. After receiving verification that the Record Drawings are complete and accurate, this Contractor shall submit new mylar reproducible copies of the final Record Drawings to the Architect. Each drawing shall be marked "RECORD DRAWING" and dated. Availability of record drawings shall be prerequisite to scheduling a final inspection of this contract and said drawings and original contract documents will be used in checking completion of the work. Non-availability of record drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled inspection by the Owner and shall be a condition precedent to final payment until such time as the discrepancy has been corrected. This contractor shall refer to Section 017800 for additional contract requirements to be performed for Record Drawings.

B. The record drawings required to be furnished under the terms of this Contract are:

Section	Reference	Drawings

	Section	Required
FIRE SUPPRESSION	21 00 00	FP0.1,

1.20 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide operating instructions to the Owner's designated representative, with respect to operating and maintenance procedures, for all equipment and systems installed. The cost of up to eight (8) hours of instruction shall be included in the Contract Price. This contractor shall refer to Section 017800 for additional contract requirements to be performed for Operating Instruction and Maintenance Manuals.

B. At the completion of the project, turn over to the Architect, three (3) complete manuals containing the following:
   1. Complete shop drawings of all equipment.
   2. Operation description of all Systems.
   3. Names, addresses and telephone numbers of all suppliers of the products, materials, equipment and Systems.
   4. Guarantees on all products, materials and equipment.
   5. Preventive maintenance instructions for all Systems.
   6. Spare parts list of all System components.

C. Each manual shall be typewritten and bound under one (1) hard cover and will be reviewed by the Architect. The manuals shall be clearly and permanently identified on the cover with the name of the project.

D. Upon completion of the instructions, this Contractor shall obtain a letter of acceptance of the instructions as being complete from the Owner. Submit a copy of said letter to the Architect.

1.21 COORDINATION DRAWINGS

A. This Contractor shall be responsible to develop and furnish all required information on the coordination drawings required under DIVISION 01 of the Specifications. Contractor shall coordinate the elevations and locations of all his systems with the work of all other trades.

1.22 CLEANING OF SYSTEMS

A. Before the Systems are accepted, all equipment shall be thoroughly cleaned, so that no dirt, dust or other foreign matter will be deposited and be detrimental to the operation of the Systems.

B. After the installation is complete, equipment with factory finished surfaces shall be cleaned and damaged or scratched spots shall be touched up with the same type and color paint applied at the factory.

C. All equipment that is to receive finish paint by the Painting Contractor, shall be cleaned by this Contractor and left ready to have surfaces prepared to receive paint.

1.23 RUBBISH REMOVAL

A. At the completion of the work, or when ordered by the General Contractor or the Architect, this Contractor shall remove from the property, all the rubbish or waste material belonging to him. Keep the job site free from accumulation of waste material and rubbish; premises must be maintained in a clean condition.

1.24 TEMPORARY STRUCTURES

A. This Contractor shall provide, on the premises and where directed by the Architect, shall maintain in good condition, and shall remove when directed, suitable and substantial watertight sheds in which he shall store all his materials and equipment.

1.25 TEMPORARY SERVICES

A. All water, electricity, fire protection and sanitary facilities required for safe and efficient construction during normal working hours shall be furnished in accordance with the General Requirements.

1.26 TESTS

A. Furnish all labor, materials, instruments, supplies and services and bear all cost for the accomplishment of the tests herein specified. Correct all defects appearing under test, repeat the tests until no defects are disclosed and leave the equipment clean and ready for use.

B. Perform any tests, other than herein specified, which may be required by legal Authorities or by Agencies to whose requirements this work is to conform.

C. Dispose of test water and wastes after tests are complete, in a manner satisfactory to the Architect and in accordance with governing regulations.

1.27 EQUIPMENT ACCESS REQUIREMENTS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the Drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels in walls and ceilings at locations indicated on the Drawings, or to permit access for adjustment, removal and the replacement and servicing of all equipment, and all other items requiring maintenance and adjustments. Access panels shall be installed by the General Contractor.

C. Coordinate the exact location of access panels in all finished spaces with the Architect.

1.28 MOTOR CHARACTERISTICS

A. Unless otherwise indicated, motors for equipment specified under this Section shall be furnished and installed by the Fire Protection Contractor and shall be as follows:
   1. Motors 1/3 HP and smaller shall be wound for 120 volts, single phase, 60 cycle AC service.

B. Unless otherwise specified, all motor starters shall be furnished and installed by the

Electrical Subcontractor.

1.29 WIRING DIAGRAMS

A. This Contractor shall furnish wiring diagrams for all equipment furnished under this Section for which wiring is to be installed by the Electrical Subcontractor.

1.30 PROCEDURE FOR TESTING

A. Partial tests shall be made during the progress of the work.

B. All labor, materials, instruments, devices and power required for testing shall be furnished by this Contractor. All tests shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

C. Repair, or if directed by the Architect, replace all defective work with new work without extra charge to the Contract. Repeat tests as directed until all work is proven to meet the requirements specified herein.

D. Restore to its finished condition any work or materials disturbed by tests.

E. This Contractor shall be responsible for removing all temporary piping connections required for tests and dispose of test water and wastes after tests in a manner satisfactory to the Architect.

F. This Contractor shall make hydrostatic, pneumatic and operational tests on all fire protection equipment in accordance with standards of the National Board of Fire Underwriters and by the NFPA.

G. Fire Protection Systems:
1. Upon completion of each phase of the fire protection system installation, this Contractor shall inspect and test the systems in the presence of the Owner's representative and the Fire Inspector.
2. The complete testing procedure for the system shall be in accordance with the requirements stated in the National Fire Protection Association's respective pamphlet for each system, but not less than the procedures specified herein.
3. In general, the Fire Protection Systems shall be tested with water to a hydrostatic pressure of 200 pounds per square inch. This pressure shall be maintained for a minimum of four (4) hours or until the system has been inspected for leaks or defects. If any leaks or defects are detected, they shall be remedied in an approved manner and the System shall be retested in the manner specified herein.
4. This Contractor shall secure all Certificates of Approval from all agencies. Each Certificate shall be delivered to the Architect before final acceptance.

H. This Contractor shall be responsible to supervise, instruct, test, document and perform all other services necessary pertaining to the installation of all water mains, fire hydrants and related components. provided under Section 331000 so that he can certify that said installation is in accordance with all NFPA requirements and shall provide a fully executed "Contractor's Material and Test Certificate for Underground Piping" in NFPA 24, Latest Edition.

PART 2 PRODUCTS

2.1 INSTALLATION REQUIREMENTS

A. This Contractor shall comply with all the rules, Codes, ordinances, regulations and requirements of all legally constituted authorities having jurisdiction over the whole or any part of the work herein specified. Regulations supplement this Specification and shall take precedence in any case of conflict.

B. All equipment and materials furnished in connection with the installation shall be new and furnished in accordance with the requirements of the Standards of the NFPA and they shall be of the best grade and quality of their respective kinds, free from natural, manufacturing or construction flaws, defects or irregularities and finish, fittings and workmanship shall be equal to the highest commercial grade.

C. Castings of all metals of all kinds shall be clean, smooth, close grained, of uniform thickness and free from all defects such as sand holes, blisters or cracks.

D. Before the installation will be accepted, the Fire Protection Contractor shall have every portion of his work in first-class working condition.

E. Where installing any of the apparatus herein called for, sufficient clearance shall be allowed to permit the removal and replacing of parts that may require future removal for repairs and replacement.

F. Exposed piping shall be installed as tight as practical to structural members.

G. Piping shall be installed neatly and square to all surfaces. Horizontal sidewall sprinklers shall be installed as tight to beams and ceilings as the sprinkler listing will allow with reference to the existence of beams.

2.2 ACCESS PANELS

A. Furnish access panels for installation by the General Contractor, in walls and non-accessible ceilings, at locations to permit access for adjustment, removal and replacement of all equipment, such as valves, drains, and all other items requiring maintenance and adjustment.

B. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that the junction can be easily reached, and the size shall be sufficient for this purpose (minimum 16" x 16"). When access panels are required in corridors or other public areas, they shall be located as directed by the Architect.

C. Panels shall be of the types specified in Section 083100 and shall be set square and flush in cooperation with the Subcontractors for other Sections of the Specifications. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of concrete masonry units.

D. Access panels Shop Drawings shall be submitted to the Architect for approval.

2.3 PIPE AND FITTINGS

A. All piping inside the building for the fire protection systems 2-1/2 inches and smaller

in size, unless otherwise specified, shall be Schedule 40 black steel pipe with threaded ends conforming to ASTM Standard A135, latest amendment, approved for use in Fire Protection Systems. All piping inside the building, three inches (3") and larger in size, unless otherwise noted, shall be Schedule 10 black steel pipe with rolled groove ends, approved for use in Fire Protection Systems.

B. Fittings for the systems shall be cast iron, unless otherwise specified. Cast iron fittings shall be extra heavy pattern for pipe sized larger than two inches (2"). Malleable iron fittings of standard weight pattern will be acceptable in sizes up to six inches (6"). U.L. approved and F.M. listed groove fittings will be allowed. All fittings shall be approved by Underwriters Laboratories for use in sprinkler systems and shall be designed and guaranteed for a working pressure of not less than 175 psi cold water pressure.

C. All close and shoulder nipples shall be of corresponding materials as the pipe and shall be extra heavy pattern.

D. All pipe shall be run true to line and grade and, in general, parallel to walls and ceilings. All open ends of the pipe lines and equipment shall be properly capped and plugged during the installation in order to keep dirt or foreign materials out of the system. All work shall be performed in a practical manner and according to the highest standards of workmanship.

E. All threaded pipes shall have full tapered threads with ends reamed out after threading and cutting.

F. The interior of all pipes and fittings shall be cleaned before assembling. All pipe threads (not fittings) shall have a thorough application of approved pipe joint cement before assembling. Any leaky joints shall be remade, as caulking will not be permitted. All pipe shall be pitched. Means shall be provided to completely drain the entire system. Capped flushing connections shall be provided at the ends of all cross mains.

G. Underground pipe shall be type 52, cement-lined, ductile pipe with class 250 mechanical fittings having Mega-Lug connections.

2.4 VALVES

A. All valves shall be of the O.S. & Y. type, of approved extra heavy flanged pattern and be designed and guaranteed for a minimum working pressure of 175 psi. All shut-off valves shall be located in conveniently accessible positions. Valves controlling the water supply to each system shall have an approved sign attached to the yoke indicating the purpose of the valve.

B. Check valve shall be of approved type for fire protection systems and be designed and guaranteed for a minimum working pressure of 175 psi.

C. Drain valves shall be Underwriters' approved all bronze angle, globe pattern with renewable disc, hose with cap and chain, ample size hand wheel and rated for a working pressure of 175 psi.

2.5 HANGERS, SUPPORTS AND SEISMIC RESTRAINTS

A. All piping shall be supported throughout the building structure by means of approved

hangers and supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

B. Pipe hangers shall be of black malleable iron, heavy petters in two (2) parts bolted together, of a type approved for Fire Protection Systems installation.

C. Hangers shall fit the pipe snugly but leave the pipe sufficient freedom of movement for expansion or contraction. Hangers which permit wide lateral motion of the pipe will not be acceptable.

D. "C" clamps for hangers on pipes will not be permitted unless installed with safety straps.

E. Maximum spacing of hangers on horizontal runs of pipe, having no concentrations of weight, shall be as follows:

SCHEDULE

Hanger Spacing for Various Pipes

Pipe Size (inches)	Spacing (feet)
1	7
1-1/4	10
1-1/2	10
2	10
2-1/2	10
3	12
3-1/2	12
4	10
6	8
8	8

F. Where Codes having jurisdiction require closer spacing, the hanger spacing shall be by Code in lieu of the distance specified herein.

G. Provide hangers at a maximum distance of two feet (2') from all changes in direction (horizontal and vertical) on both sides of concentrated loads independent of the piping.

H. Hangers, in general, for all horizontal piping shall be adjustable clevis type hangers.

I. All vertical drops and run out pipes shall be supported by extension style, split ring type hangers.

J. All horizontal piping shall be suspended from the building by mild steel rod connecting the pipe hanger to inserts, angle brackets and lag screws, by the building construction in accordance with the following table:

Pipe Size (inches)	Rod Diameter (inches)
1 - 3	3/8
3 - 6	1/2
8	3/4

K. Hanger rods for other installation shall be sized in accordance with recommended load capacities of Specification A.S.T.M. Designation A-107, latest amendment.

L. Remove rust from all ferrous hanger equipment (hangers, rods and bolts) and apply one (1) coat of rust inhibiting paint immediately after erection.

M. All piping installed under this Section of the Specifications shall be independently supported from the building structure and not from the piping, ductwork or conduit of other trades. All supplementary steel required to meet requirements specified herein shall be furnished and installed by this Contractor.

N. In areas where support of the pipe by hangers is not possible or feasible, piping shall be supported by an adjustable pipe roll stand with base plate equal to Figure 274, as manufactured by Grinnel Corporation. This installation method shall be done in accordance with the requirements of all pertinent Codes.

O. All supplementary steel throughout the project for this Section of the Specifications, both suspended and floor mounted, shall be furnished and installed by the Fire Protection Contractor and shall be subject to the approval of the Architect.

2.6 SLEEVES AND INSERTS

A. This Contractor shall be held responsible for the location of and maintaining in proper position, of sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event that failure to do so require cutting and patching of finished work, it shall be done at this Contractor's expense by the General Contractor.

B. All pipes passing through walls or partitions shall be provided with sleeves having an internal diameter one inch (1") larger than outside diameter of the pipe.

C. Unless otherwise indicated and/or specified herein, all sleeves through masonry floors or interior masonry walls shall be Schedule 40 black steel pipe, set flush with finished wall or set one inch (1") above finished floor surfaces, or as indicated on the architectural drawings. Sleeves in stairwells shall be set flush with finish floor.

D. Sleeves through interior non-masonry partitions shall be 22 gauge galvanized sheet steel, set flush with finished surfaces of the partitions.

E. Sleeves through interior walls adjacent to all building expansion joints shall be two (2) pipe size diameters larger than diameter of pipe.

F. This contractor shall be responsible to review all firestopping of all piping and related components for completeness. All firestopping materials and installation will be by the General Contractor under Section 07 84 00.

2.7 ESCUTCHEONS

A. Escutcheons shall be installed around all exposed bare pipe. Escutcheons shall be of sufficient outside diameters to cover the sleeve opening and shall fit snugly around the bare pipe.

B. Escutcheons shall be cast brass, grey primed finish and provided with a set-screw to

properly hold escutcheons in place.

2.8 SPRINKLER HEADS

A. All sprinkler heads shall be quick response type, of 1/2 inch nominal orifice size. Heads shall be listed by Underwriters' Laboratories, Inc. and approved by Factory Mutual. All heads shall be manufactured by a single manufacturer.

B. All heads shall have a temperature rating of 165°F unless the distance from a heat source or location of head warrants, by Code, a head of another degree rating.

C. The following sprinkler heads shall be installed in the areas outlined:
1. All upright sprinkler heads in unfinished spaces shall be of brass, with deflectors and fusible links.
2. All pendant sprinkler heads, unless noted or designated otherwise, shall be concealed type heads having a ceiling plate of a color to match that of the ceiling it is mounted in. Heads in unheated spaces shall be of the dry pendant type with a maximum length of 36".
3. All sidewall heads in heated areas shall be chrome-plated units with sidewall deflectors and fusible links. Sidewall heads serving unheated areas shall have shafts a minimum of 18" in length.
4. All sprinkler heads in shower areas shall be wax coated.
5. All sprinkler heads in the Gymnasium shall have protective guards on them.
6. All sprinkler heads in rooms with black ceilings shall have black sprinkler heads.
7. Concealed sprinkler head flush covers are to match adjacent finishes and shall be coordinated with architect.

2.9 SPARE SPRINKLER HEADS AND CABINETS

A. The Fire Protection Contractor shall furnish and install, where directed by the Architect, a metal cabinet containing spare sprinkler heads and wrenches.

B. The cabinet shall have shelves for storing the spare heads in an orderly manner. The shelf spaces shall be subdivided to segregate the sprinkler heads of each type and clearly identify them with approved markings. The cabinets shall have proper arrangement for hanging the wrenches.

C. Spare sprinkler heads shall be provided in numbers, by NFPA Pamphlet #13, corresponding to the types and temperature ratings of those installed in the premises (6 minimum of each type).

D. Wrenches shall be provided in a number so that there will always be a minimum of two (2) wrenches of each type required to remove any sprinkler head on the premises.

2.10 ALARM CHECK VALVE

A. Alarm check valve shall be approved type for a wet pipe sprinkler system complete with retarding chamber, water operating gong, drain valve, pressure gauges and other required trimmings. Valve shall be equal to Victaulic Model 751 for variable pressure vertical installation, sizes as indicated on the drawings, with electrical gong. Electric gong shall be located on outside of building with head and identification tag.

2.11 BACKFLOW PREVENTER

A. This Contractor shall furnish and install an eight-inch (8") Double Check Valve Assembly, where shown on the drawings. The device shall be a Watts Model No. LF-709-UL/FM-S-FDA, or equal. Devices shall be by Ames, or Wilkins.

B. One (1) complete rebuilding kit shall be supplied with the Double Check Valve Assembly.

C. This Contractor shall be responsible to file design data sheets along with cuts of the double check valve assembly, and obtain approval of same from the local Water Department and the Department of Environmental Protection.

2.12 FIRE VALVE CABINETS

A. This Contractor shall furnish and install fire valve cabinets complete with all related accessories where shown on the drawings. All cabinets in fire-rated walls shall be fire-rated. Cabinets shall be as follows:

Type "A" - A recessed steel cabinet, equal to Potter-Roemer, Inc. Figure 1880 with door style of Suffix "A" and 2-1/2" x 1-1/2" valve assembly. Assembly shall include a Potter-Roemer, Inc. 2-1/2" rough brass, 300 lb., U.L. pressure-restricting angle valve No. 4085C; 2-1/2" x 1-1/2" brass reducer cap.
Valve, reducer and all related components shall be chrome-plated.

All hose valve connections shall face outward at approximately a 45 degree angle to permit easy connection of fire hoses.

Provide sign for each fire department valve that reads MANUAL STANDPIPE FOR FIRE DEPARTMENT USE ONLY.

2.13 FIRE DEPARTMENT CONNECTIONS & INDICATER VALVE

A. Fire department connections shall be Underwriters' Laboratories and NFPA approved units with a "Storz" type connection. Units shall be manufactured of heavy bronze complete with bronze caps, plugs and chains. Provide identification plate of cast brass with the words "AUTO. SPKR. – MANUAL STANDPIPE" in raised lettering.

2.14 DRAINS AND TEST CONNECTIONS

A. Drains and test connections shall be provided in the systems by all governing Codes, regulations and ordinances.

B. Drains shall be provided at low point in piping, at base of risers, and wherever necessary to insure that all portions of the piping may be completely drained.

C. Test connections shall consist of drain piping with a one inch (1") shutoff valve (O.S. & Y.) type, piped outdoors to a safe place of discharge. Pipe through outside wall shall be galvanized steel pipe with sleeve caulked watertight and plugged with a brass plug.

2.15 FIRE PROTECTION ALARMS

A. O.S. & Y. valve monitor switches and sprinkler system's flow and pressure sensors shall be furnished and installed by the Fire Protection Contractor and wired by the Electrical Subcontractor. The Fire Protection Contractor shall coordinate with the Electrical Subcontractor on this portion of the system. Monitor switches shall be installed on all O.S. & Y. valves and shall be equal to Notifier OSY2 and be fitted with 2-SPDT switches. Flow switches shall be installed as indicated on the drawings and shall be equal to Notifier WFD 10/40 with adjustable delay. Electric alarm bells furnished and installed by Fire Protection Contractor and wired by the Electrical Contractor.

2.16 SYSTEM DIAGRAM

A. At the completion of the work, next to the alarm riser, provide a small scale plan of each floor of the building indicating zones, with locations of all control valves, low point drains and inspector's tests. Plans shall be 1/32" = 1'-0" in scale neatly drawn and color-coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall adjacent to the header.

PART 3 EXECUTION

3.1 OPERATION AND START-UP

A. The Fire Protection Contractor shall furnish all labor, materials and equipment necessary to place the equipment into operation and then start and operate all systems to demonstrate the fitness of the installation.

3.2 COORDINATION

A. The structure and its appurtenances, clearances and the related services, such as plumbing, heating, ventilation and electric service, have been planned to be adequate and suitable for the installation of equipment specified under this Section. The Owner will not assume any increase in cost caused by different requirements peculiar to a particular make or type of equipment and any such incidental cost shall be borne by the Fire Protection Contractor. He shall be responsible for the proper installation and location of his required sleeves, chases and inserts and see that they are set in the forms before the concrete is poured. He shall be responsible for his work and equipment furnished and installed by him until the completion and final acceptance of this Contract, and he shall replace any work which may be damaged, lost or stolen, without additional cost to the Owner.

B. In the event there is a conflict or inadequate space for the proper installation of Fire Protection equipment, the Fire Protection Contractor shall prepare a scaled (1/4" = 1'-0" size) composite drawing, showing the building structure and all equipment and items affecting the installation, to clearly identify the areas of conflict. The Fire Protection Contractor shall submit four (4) copies of the drawing, along with a written explanation of the problem, to the Architect for his review and determination on what action to take to resolve the conflict.

C. It shall be the duty of the Fire Protection Contractor to furnish full information to all trades relative to the work they are to do in connection with work under this Section. This includes data for wiring, including wiring diagrams, equipment foundations, pipe connections and related components furnished under other Sections.

3.3 PAINTING

A. The Fire Protection Contractor shall apply one (1) coat of anti-rust paint and one (1) coat of flat black enamel to all support steel, hangers and other steel or iron elements of the Fire Protection system, furnished by him, which will be enclosed or above ceilings when the project is completed.

B. Paint shall be omitted from all items with a galvanized finish.

C. All surfaces to be painted shall be free of dirt, scale, rust, grease and oil. Rust spots are to be wire brushed. Ambient temperature shall be in accordance with paint manufacturer's requirements when painting is being performed.

D. The Fire Protection Contractor shall touch up, with spray paint, all scratched or damaged surfaces of equipment with factory finish. Spray paint shall be the same color and type as factory finish.

E. The Painting Contractor shall paint all mechanical equipment, enclosures, covers, panels, insulation, conduit and other equipment exposed to view, except factory finished items. Care shall be taken not to paint over equipment nameplates. The Fire Protection Contractor shall leave surfaces to be painted ready to receive paint. The Painting Contractor shall apply paint in accordance with the Painting and Finishing portion of this Specification. Colors shall be selected by the Architect.

3.4 WORKING PLANS, FLOW TEST AND HYDRAULIC CALCULATIONS

A. General performance criteria for the fire protection systems has been developed on these Contract Documents. The Contractor is responsible to engage a qualified Massachusetts registered fire protection engineer to prepare the final installation drawings of the fire protection systems. The contractor’s design of the fire protection systems and supporting calculations shall be submitted to the Architect for review, but solely for the purpose of reviewing relative to the criteria established herein. The review of the Contractor's engineer's design shall not, in any manner or respect, relieve the Contractor of full responsibility for any deviations made from the contract drawings of the fire protection systems. It requires preparation and submission of drawings, procurements of approvals and provision of a complete functional system of automatic sprinklers and standpipes.

B. Before commencement of any work, submit and obtain all approvals of all plans and calculations from F.M. or other Insuring Agent prior to submittal to the Agency having jurisdiction, including the Fire Department, for final approval. Furnish copies of approved working plans to the Architect promptly after obtaining such approvals.

C. Plans must show the following information in suitable fashion:
1. Name of Owner.
2. Names and addresses of Architect and Engineers.
3. Location of project.
4. North point.
5. Drawing scale.
6. Plans of all floors, partitions, exits, beams, lights, unit heater, diffusers, registers, duct over four feet (4') in width and ceiling heights.
7. Location, name, type, temperature rating and make of sprinkler heads including dimensioning of heads.
8. Structural beams and penetrations.

9. Source of water supply, size of pipe, and pressure available.
10. Number of sprinklers on each riser, area of each room and total number of rooms in the building, including location and size of risers, mains, branches, and most remote area.
11. Cutting and lengths of pipe.
12. Make, type, model, size and location of sprinkler water flow alarms and tamper switches.
13. Type of hangers, inserts and sleeves.
14. Inspector's test connections, drain pipes and test pipes.
15. Crosses, riser nipples and size.
16. Control gate, checks and flushing connections.
17. Riser diagram of entire schematic system indicating all alarms, valves, tamper switches, floor control valves, mains, risers, source of supply, quantity of sprinklers in each fire area on each floor, water pressure at each floor and height of each floor with regard to water supply source.
18. Symbol list and abbreviations for entire Fire Protection System.

D. This Contractor shall be responsible to develop complete hydraulic calculations for the Fire Protection System as shown on the Drawings. This Contractor shall perform his own flow tests at building and base his calculations on the flow test results. Elevations of both flow and gauge hydrants must be included with all flow data. Flow test results and hydraulic calculations are to be submitted to the Architect, the Owner's Insuring Agent and the Fire Department for review. A ten (10) psi "cushion" is the minimum required for the design of the piping system.

Exiting Flow Test Information:
Location: Beverly Middle School – Cabot Street, Beverly MA.
Date: September 11, 2015
Start Time: 10:00a.m., Duration of Test: 2 Min.
Performed by: PARE Corporation (with assistance from Beverly Water Personnel)
Purpose of Test: Determine available fire flow at 20 psi residual pressure.
Consumption Rate During Test: 1,425 gpm @ 2 min. = 2,850 gallons.

Flow Test Results at Hydrant:
Flow Hydrant, flow rate 1,425 gpm, 2-1/2 inch nozzle, Static Pressure 90 psi, Residual Pressure 72 psi.

Residual Hydrant:
Nozzle size 2-1/2 inch,
Static Pressure 92 psi,
Residual Pressure 89 psi.

Note: Pressure read from Pitot tube gauge corresponding to a flow rate of 1,425 gpm was approximately 72 psi. Friction coefficient of 0.9 is factored into the Pitot tube gauge.

The results of this flow test are indicative of the conditions of the water system at the time of the test. Other factors, such as available fire reserve (i.e., storage tank volume), operation of booster pumps, etc., were not considered in this evaluation.

END OF SECTION

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SECTION 22 00 00
PLUMBING
(Filed Sub-Bid Required)

INDEX

PART 1 GENERAL....3
1.1 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING SUB-BIDS....3
1.2 GENERAL REFERENCES....3
1.3 SCOPE OF WORK....4
1.4 RELATED WORK SPECIFIED ELSEWHERE....5
1.5 DEFINITIONS....6
1.6 INTENT....6
1.7 CODES, REGULATIONS AND STANDARDS....6
1.8 DRAWINGS AND CONFLICTS IN THE WORK....7
1.9 EXCHANGE OF INFORMATION AND COORDINATION....7
1.10 WORKMANSHIP....7
1.11 SITE INVESTIGATION....8
1.12 TAXES AND INSURANCE....8
1.13 PERMITS AND INSPECTIONS....8
1.14 CONTRACT COST BREAKDOWN....8
1.15 GUARANTEE....8
1.16 MATERIALS....9
1.17 MATERIALS AND EQUIPMENT HANDLING....9
1.18 MAINTENANCE AND PROTECTION OF MATERIALS....9
1.19 SHOP DRAWINGS AND MATERIAL SCHEDULE....9
1.20 LOCATION OF FIXTURES AND EQUIPMENT....10
1.21 RECORD DRAWINGS....10
1.22 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS....11
1.23 COORDINATION DRAWINGS....12
1.24 CLEANING OF SYSTEMS....12
1.25 RUBBISH REMOVAL....12
1.26 TEMPORARY STRUCTURES....12
1.27 TEMPORARY SERVICES....12
1.28 TESTS....12
1.29 EQUIPMENT ACCESS REQUIREMENTS....13
1.30 MOTOR CHARACTERISTICS....13
1.31 WIRING DIAGRAMS....13
1.32 CROSS CONNECTIONS....13
1.33 CLEANING, FLUSHING AND TESTING....13
1.34 PROCEDURE FOR TESTING....14
1.35 COMMSIONING REQUIREMENTS....15
PART 2 PRODUCTS....15
2.1 INSTALLATION REQUIREMENTS....15
2.2 PIPE AND FITTINGS....16
2.3 JOINTS AND COUPLINGS....16
2.4 VALVES....18
2.5 PIPE HANGERS, SUPPORTS, CHANNELS AND SEISMIC RESTRAINTS....18
2.6 ACCESS PANELS....20
2.7 PIPE SLEEVES....21
2.8 INSULATION....21
2.9 CLEANOUTS....22

2.10 TRAPS 22
2.11 UNIONS AND NIPPLES 23
2.12 SHOCK ABSORBERS 23
2.13 VACUUM BREAKERS 23
2.14 PIPING ACCESSORIES 24
2.15 VENTS THROUGH THE ROOF 24
2.16 DRAINS 24
2.17 WALL HYDRANTS, HOSE BIBBS AND ROOF HYDRANT 25
2.18 EQUIPMENT CONNECTIONS 25
2.19 GAS SOLENOID VALVES 26
2.20 MASTER GAS VALVE BOXES 26
2.21 GAS SERVICE AND METER 26
2.22 INTERIOR GREASE INTERCEPTORS 26
2.23 BACKFLOW PREVENTERS 27
2.24 TRAP PRIMERS 27
2.25 EXPANSION JOINTS AND LOOPS 27
2.26 GAS FIRED HOT WATER HEATING SYSTEM 28
2.28 EMERGENCY SHOWER ELECTRIC HOT WATER SYSTEM 28
2.29 DOMESTIC WATER TEMPERING SYSTEMS 28
2.30 EMERGENCY SHOWER WATER TEMPERING VALVE 29
2.31 HOT WATER CIRCULATORS 29
2.32 ACID NEUTRALIZATION SYSTEM 29
2.33 PLUMBING FIXTURES 31
2.34 HEAT MAINTENANCE CABLE 35
2.35 EXTERIOR GREASE INTERCEPTOR 35
2.38 GAS TRAIN VENT PIPING 35
2.40 WATER METER 36
2.41 EMERGENCY SHOWER SYSTEM SOLENOID VALVE/TIME CLOCK 36
2.45 VALVE TAGS, NAMEPLATES AND CHARTS 36
2.46 PIPE IDENTIFICATION 37
PART 3 EXECUTION 37
3.1 OPERATION AND START-UP 37
3.2 COORDINATION 38
3.3 PAINTING 38
3.4 PROTECTION OF SYSTEMS 39
3.5 SANITARY AND STORM DRAINAGE SYSTEMS 39
3.6 WATER SYSTEMS 40
3.7 GAS DISTRIBUTION SYSTEMS 41
END OF SECTION 41

SECTION 22 00 00
PLUMBING
(Filed Sub-Bid Required)

PART 1 GENERAL

1.1 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING SUB-BIDS

A. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope at a time and place as stipulated in the "ADVERTISEMENT FOR BIDS". The following should appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER
PLYMOUTH NORTH HIGH SCHOOL
PLYMOUTH, MA

SUB-BID FOR: Section 22 00 00, Plumbing

B. Every sub-bid submitted for work under this Section shall be on proper forms. Sub-bid forms may be obtained at the office of the Architect.

C. Sub-bids shall be accompanied by BID BOND or CASH or CERTIFIED CHECK or a TREASURER'S CASHIER'S CHECK issued by a responsible bank or trust company payable to the AWARDING AUTHORITY in the amount of 5% of the sub-bid. A sub-bid accompanied by any other form of bid deposit than those specified is rejected.

D. Each Sub-Bidder shall list in Paragraph E of the "Sub Bid Form" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for the Sub-Trade requires such listing, provided that, in the absence of any contrary provisions in the Specifications, any Sub-Bidder may, without listing any bid price, list his own name in said Paragraph E for each such class of work or part thereof and perform that work with persons on his own payroll, if such Sub-Bidder, after Sub Bid openings, shows to the satisfaction of the Awarding Authority, that he does customarily perform such class of work or the part thereof with persons on his own payroll and is qualified to do so. This Section of the Specifications requires that the following class(es) of work shall be listed in Paragraph E under the conditions herein.

CLASS OF WORK	REFERENCE PARAGRAPH
Insulation	2.8

E. In any case in which the sub-bidder intends to perform the class of work listed above with persons of his own staff, he shall nevertheless list his own name therefore under Paragraph E of the FORM FOR SUB-BID.

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Conditions Contract for

Construction Services and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. Work Included: The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all plumbing work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either or, in the opinion of the Architect, as being required and, in general, is as follows:

1. Complete sanitary, waste and vent systems, including kitchen waste and garage waste connecting to all fixtures, equipment and related items, terminating at 10'-0" off the building, as shown on the Drawings or as required by code for a “Designated System”.
2. Complete storm drainage systems connecting to all roof drains, downspouts and related items, terminating at locations 10'-0" off the building, as shown on the Drawings or as required by code for a “Designated System”.
3. Complete domestic cold water, hot water and hot water return piping system, including connection to all fixtures, equipment and related items as required.
4. Acid waste and vent systems from all sinks and fixtures requiring same, including acid neutralization system and terminating at location 10’-0”’ off the building, as shown on the drawings.
5. Non-potable water systems from backflow preventors on the domestic water system to all HVAC equipment and science area fixtures and equipment.
6. A tempered emergency water system to supply all emergency showers and eyewashes.
7. All valves for water, and gas piping systems.
8. Roof Drains, Floor drains and area drains.
9. Cleanouts, thermometers, strainers.
10. Wall hydrants, hose bibbs.
11. Circulator pumps.
12. All plumbing fixtures, trim and fixture supports.
13. Gas-fired water heaters.
14. Exterior Grease Interceptors.
15. Insulation of all potable and non-potable hot, cold, hot water return piping, chilled water piping, storm piping and roof drain bodies.
16. Provide sanitary, gas, waste and vent piping, hot and cold water piping including final connections to all equipment supplied under other sections of this Specification complete with all incidental devices.
17. Valve tags, valve charts, nameplates, pipe identification and record drawings.
18. Secure all permits and pay all fees relating to the work.
19. Complete gas piping systems from gas meter, including final connections to all equipment.
20. All operating and maintenance manuals, certification letters and Certificates of Approval. Testing, sterilization and guarantees.
21. All hangers, seismic restraints, inserts, sleeves, expansion loops, expansion compensators, anchors, guides, strainers, gauges, thermometers plus all related accessories required for a complete installation of each system, as

specified herein and/or indicated on the drawings.

22. All supplementary steel for piping and equipment supports.

B. Items to be Furnished Only: Furnish the following items for installation by the designated Sections:

1. Access Panels
   a. Access panels for access to plumbing equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

C. The Plumbing Contractor shall be responsible for all cutting related to the work of the Section except in finished surfaces. Patching is the responsibility of the trade effected.

1. For coordination of cutting and patching, refer to Section 013100 PROJECT MANAGEMENT AND COORDINATION.
2. For cutting and patching specifications, refer to Section 017329, CUTTING AND PATCHING.

D. The work of this Section is shown on Drawings numbered P0.1, P0.01, P0.12, P0.13, P0.14, P1.01, P1.11, P1.12, P1.13, P1.14, P1.21, P1.22, P1.23, P1.24, P1.32, P1.33, P1.34, P1.42, P1.43, P1.44, P1.51, P1.52, P1.53, P1.54, P2.1,

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. The following related work shall be performed by the Designated trades and under the listed SECTION:

1. Excavation and backfill shall be performed by the General Contractor: SECTION 310000, EARTHWORK.
2. On-site storm drainage systems, as shown on the Drawings: STORM DRAINAGE SYSTEMS, SECTION 334000.
3. Continuation of sanitary drainage systems beyond 10'-0" off the building, as shown on the drawings: SANITARY SEWERAGE, 333000.
4. Water service up to a point 6" beyond the foundation wall, as shown on the drawings WATER DISTRIBUTION, 331000.
5. Wiring of equipment requiring power connections and furnished by the Plumbing Contractor and starting devices for all motors incidental to the Plumbing Systems shall be furnished and installed by the Electrical Contractor: ELECTRICAL, SECTION 26 00 00.
6. Painting of piping, fittings, coverings, hangers, supports and all equipment not specifically outlined to be painted in this Section, shall be painted by the Painting Contractor: PAINTING, SECTION 099100.
7. Electricity and water for all tests and temporary operation of Plumbing Systems: TEMPORARY FACILITIES AND CONTROLS, SECTION 015000.
8. Concrete equipment pads for Plumbing equipment: CAST IN PLACE CONCRETE, SECTION 033000.
9. Equipment access panels for Plumbing equipment shall be furnished by the Plumbing Contractor and installed by the General Contractor or respective Subcontractor.
10. Flashing of all vents through the roof shall be performed by the Roofing Contractor, ROOFING AND FLASHING, SECTION 070002.

1.5 DEFINITIONS

A. "Concealed" shall be defined as areas where work is located in chases, walls, partitions, shafts, and above ceilings.

B. "Piping" shall mean, in addition to pipe, all fittings, valves, hangers, and other accessories relating to such piping systems.

C. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

D. "Plumbing Subcontractor" shall mean the filed sub-bid contractor under this DIVISION 22 00 00.

1.6 INTENT

A. All work shall be in accordance with the arrangement, details and locations, as indicated on the Contract Drawings, Reference Drawings and any supplemental addenda, bulletins or drawings issued by the Architect. Layouts are diagrammatic and final arrangement of equipment shall suit field conditions. Install all necessary fittings and equipment offsets required to meet job conditions. The Drawings are not intended to be scaled, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations. Work installed in a manner contrary to that shown on the Drawings, or interfering with the work of another trade, shall be removed and reinstalled when so directed by the Architect. Discrepancies and questionable points shall be immediately reported to the Architect for clarification.

1.7 CODES, REGULATIONS AND STANDARDS

A. All work shall be installed in conformance to the governing Codes, Regulations and Ordinances. It shall be the responsibility of this Contractor to familiarize himself with all governing Codes, Regulations and ordinances and report any non-compliance of the Plans and Specifications to the Architect, prior to entering into a contract. All the above requirements shall take precedence over the Plans and Specifications. These requirements are minimum criteria and no reductions permitted by Code will be allowed without written permission of the Architect.

B. All workmanship, methods and materials shall meet the highest standards of the trade and, in general, shall conform to the standards of the following associations:

American National Standards Institute	(ANSI)
American Society of Mechanical Engineers	(ASME)
National Board of Fire Underwriters	(NBFU)
National Fire Protection Association	(NFPA)
National Electrical Manufacturers Association	(NEMA)
Occupational Safety and Health Act	(OSHA)
Underwriters' Laboratories	(UL)
American Society of Testing Materials	(ASTM)
National Sanitation Foundation	(NSF)
Massachusetts Plumbing and Gas Code	
Massachusetts State Building Code, NFPA 1	
Regulations and Ordinances of the Town of Beverly	
Americans with Disabilities Act	(ADA)

1.8 DRAWINGS AND CONFLICTS IN THE WORK

A. The Drawings and Specifications are intended to be complementary. Any materials shown or specified in one, but not in the other, reasonably implied and usually included under good industry practice and/or required by applicable Codes and Regulations for the proper and safe completion and operation of the work described herein, shall be furnished and installed by this Contractor at no additional cost to the Owner. Drawings show general arrangement of equipment and are not intended to indicate the exact dimensions of runs.

1.9 EXCHANGE OF INFORMATION AND COORDINATION

A. All systems and equipment covered by this Section of the Specifications shall not be installed in congested and problem areas without first coordinating the installation of same with the other trades and the General Contractor. This Contractor shall, at his own expense, relocate all equipment installed in congested or problem areas should they interfere with the proper installation of the equipment to be installed by other trades and by the General Contractor.

B. Particular attention shall be directed to the coordination of Systems with all equipment of other trades installed in the ceiling areas. Coordinate, with the other trades, the elevations of all equipment in hung ceiling areas to insure adequate space for the installation of fixtures before said equipment is installed.

C. Furnish to the General Contractor and all other Contractors all information relative to the portion of the installation specified in this Section that will affect them, sufficiently in advance, so that they may plan their work and installations accordingly.

D. In the case of failure on the part of this Contractor to give proper information, as indicated above, sufficiently in advance, this Contractor will pay for all backcharges incurred by the General Contractor and other Contractors for the modification and/or relocation of any portion of the work already performed by them in conjunction with this Contract due to this Contractor's delay or for having given incorrect information.

E. Obtain from the other trades, all information relative to the work covered by this Section of the Specifications, which this Contractor is to execute in conjunction with the installation of their respective equipment.

F. In the event that conflicts, if any, cannot be settled rapidly and amicably between the affected trades with work proceeding in a workmanlike manner, then the Architect shall decide which work is to be relocated and his judgement shall be final and binding.

1.10 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished, in every respect, in a workmanlike and substantial manner. It is not intended that the Drawings show every detail, but this Contractor shall furnish and install all such parts as may be necessary to complete the work in accordance with the best trade practice and to the satisfaction of the Architect and the Owner. The Owner shall have the right to reject any part of the work in case the workmanship is not of satisfactory quality and this Contractor shall replace same with acceptable work at his own expense.

1.11 SITE INVESTIGATION

A. It shall be the responsibility of the Bidders to acquaint themselves with the available information, before submitting their bid. Bidders must acquaint themselves with the existing conditions and shall study all Architectural, Structural, Mechanical and Electrical Drawings, as well as the Specifications. The Bidders shall fully inform themselves of all local and state Code requirements. Extra compensation will not be given for obvious conflictions apparent at the time of the start of the project.

1.12 TAXES AND INSURANCE

A. This Contractor shall include in his bid, applicable federal, state and local taxes and the premiums of the insurance required by the General Conditions of the Contract. This Project is exempt from Massachusetts State Sales Tax. Tax exemption number will be given to the successful bidder.

1.13 PERMITS AND INSPECTIONS

A. This Contractor shall obtain and pay for all the permits required for this Section of the work. He shall also obtain and pay for all the inspections and tests required. Defects discovered in work, materials and/or equipment shall be replaced at no cost to the Owner, and the inspection and test shall be repeated. When work is completed, this Contractor shall furnish a Certificate of Inspection and Approval, to the Owner, before final payment of the Contract will be allowed. Permits to be secured through the Town of Beverly.

B. Refer to Instruction to Bidders and General Conditions Contract for Construction Services.

1.14 CONTRACT COST BREAKDOWN

A. At the start of construction, submit a breakdown of material and labor costs to aid the Architect in determining the value of the work installed, as the job progresses. The cost breakdown shall itemize categories of materials or portions of systems, as may be the case, to place a value on the work as it is installed.

B. No requisitions will be paid until after the breakdown is delivered to the Architect.

1.15 GUARANTEE

A. Unless otherwise noted, all materials, items of equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in material and workmanship for a period of not less than one (1) year from the date of final acceptance of the work. Any fault due to defective or improper material or workmanship which may develop within that period, shall be made good, forthwith, by and at the expense of this Contractor, including all other damage done to areas, materials and other systems resulting from this failure.

B. This Contractor shall guarantee that all elements of the Systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

C. Upon receipt of notice from the Owner of failure of any part of the Systems during

the guarantee period, the affected part or parts shall be promptly replaced by this Contractor, at no charge to the Owner.

D. This Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.16 MATERIALS

A. Materials shall be the best of their respective kinds and in full accord with the most modern mechanical construction. All materials shall be new.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed under this Contract, whether or not specifically shown on the Drawings or specified herein.

C. It is the intent of the Specifications that one manufacturer be selected, not a combination, for any particular classification of materials.

D. Where materials, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish the standard of desired quality and style and shall be the basis of the bid. Unless noted otherwise these manufacturers are not proprietary and it is understood that variations in configuration and appearance do not eliminate other manufacturers as equals.

1.17 MATERIALS AND EQUIPMENT HANDLING

A. This Contractor shall do all handling of his materials and equipment and the resulting cleanup, at his expense, in a safe and satisfactory manner. Special attention shall be paid to the protection of life and property and the equipment or apparatus handled, and any corresponding damages shall be replaced, repaired or paid for by this Contractor, as approved by the Architect. This Contractor shall provide all rigging, hoisting and staging required to complete the work of this Section, unless specifically noted otherwise.

1.18 MAINTENANCE AND PROTECTION OF MATERIALS

A. This Contractor shall be responsible for the maintenance and protection, from loss or damage of all causes, of all equipment, materials and tools supplied by him and stored or installed on the job site, until final acceptance of the project by the Owner.

B. This Contractor shall store his materials and equipment in the location designated by the Owner and maintain the storage area in a safe condition.

C. This Contractor shall clean, patch and repair any material and finishes of the building or its contents damaged during the execution of this Contract.

1.19 SHOP DRAWINGS AND MATERIAL SCHEDULE

A. Submit complete Shop Drawings in accordance with provisions of the General Conditions and Supplementary Conditions of the Contract and Section 013300, SUBMITTAL PROCEDURES.

B. Within 30 days after the date of Notice to Proceed and before purchasing any materials or equipment, submit to the Architect for approval, a complete list of the names of manufacturers of all equipment proposed to fulfill the work of this Section. After the list has been processed by the Architect, submit complete Shop Drawings of all equipment and materials. Do not order any material or equipment until approval has been obtained from the Architect.

C. The approval of equipment and materials does not relieve this Contractor from the responsibility of Shop Drawings errors in details, sizes, quantities and dimensions which deviate from the Specifications, Contract Drawings and/or job conditions as they exist.

D. If apparatus or materials are substituted by this Contractor for those specified, and such substitution necessitates changes in any mechanical or electrical equipment, or alteration to connections, piping, supports, or construction, same shall be provided. This Contractor is to assume the cost and entire responsibility thereof. The Architect's permission to make such a substitution shall not relieve this Contractor from full responsibility for the work.

E. Changes to work already performed, made necessary by delays in Shop Drawing approvals, are the responsibility of this Contractor.

1.20 LOCATION OF FIXTURES AND EQUIPMENT

A. The Architect will establish the exact location of all fixtures, equipment and devices to be located in finished spaces of the building. Such precise locations are, for the most part, indicated on the Architectural plans of the various spaces, and it shall be the responsibility of this Contractor to obtain instructions from the Architect for the location of any items whose location is not specifically given on the Architectural Drawings. Any work installed contrary to the Architectural Drawings, or without the prior approval of the Architect, shall be relocated and any necessary changing or patching of the surrounding work shall be done at the expense of this Contractor.

1.21 RECORD DRAWINGS

A. The Architect will provide two (2) sets of black or blue line on white drawings to the General Contractor for the purpose of maintaining record drawings, one set of which shall be maintained at the site and on which, at all times, shall accurately, clearly and completely show the actual installation of all work of this SECTION. At the completion of the contract, this Contractor shall submit to the General Contractor a complete set of record drawings showing all "As Built" conditions. After checking the aforementioned drawings, the General Contractor shall certify that they are complete and correct and shall submit the record drawings to the Architect. The Architect may have his Consulting Engineers review the drawings to determine if the installations, as shown thereon, are complete and accurate. After receiving verification that the Record Drawings are complete and accurate, this Contractor shall submit new mylar reproducible copies of the final Record Drawings to the Architect. Each drawing shall be marked "RECORD DRAWING" and dated. Availability of record drawings shall be prerequisite to scheduling a final inspection of this contract and said drawings and original contract documents will be used in checking completion of the work. Non-availability of record drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled inspection by the Owner and shall be a condition precedent to final payment until such time as the discrepancy has been corrected. This contractor shall refer to

Section 001780 for additional contract requirements to be performed for Record Drawings.

B. The record drawings required to be furnished under this Contract are:

Section	Reference Section	Drawings Required
Plumbing	22 00 00	P0.1, P0.01, P0.12, P0.13, P0.14, P1.01, P1.11, P1.12, P1.13, P1.14, P1.21, P1.22, P1.23, P1.24, P1.32, P1.33, P1.34, P1.42, P1.43, P1.44, P1.51, P1.52, P1.53, P1.54, P2.1,

1.22 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner's operating and maintenance personnel in the proper operation and maintenance of the equipment and systems installed. Instruction period shall be two (2) eight-hour days.

1. "Training of the Tenant's and Building Owner's operation and maintenance personnel is required in cooperation with the Tenant's and Building Owner's Representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representative after submission and approval of formal training plans. Refer to Commissioning Specification, Section 019100, for contractor training requirements.

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B At least two (2) months prior to occupancy or final acceptance of the project, turn over to the Architect, three (3) complete manuals containing the following in accordance with CLOSEOUT SUBMITTALS, SECTION 017800:

1. Complete shop drawings of all equipment.
2. Operation description of all Systems.
3. Names, addresses and telephone numbers of all suppliers of the products, materials, equipment and Systems.
4. Guarantees on all products, materials and equipment.
5. Preventive maintenance instructions for all Systems.
6. Spare parts list of all System components.

C. Each manual shall be typewritten and bound under one (1) hard cover and will be reviewed by the Architect. The manuals shall be clearly and permanently identified on the cover with the name of the project.

D. "This contractor shall refer to Section 011780 for additional contract requirements to be performed for Operating Instructions and Maintenance Manuals."

E. Upon completion of the instructions, this Contractor shall obtain a letter of acceptance of the instructions as being complete from the Owner. Submit a copy of said letter to the Architect.

1.23 COORDINATION DRAWINGS

A. This Contractor shall be responsible to develop and furnish all required information on the coordination drawings required under DIVISION 1 of the specifications. Contractor shall coordinate the elevations and locations of all his systems with the work of all other trades.

1.24 CLEANING OF SYSTEMS

A. Before the Systems are accepted, all equipment shall be thoroughly cleaned, so that no dirt, dust or other foreign matter will be deposited and be detrimental to the operation of the Systems.

B. After the installation is complete, equipment with factory finished surfaces shall be cleaned and damaged or scratched spots shall be touched up with the same type and color paint as applied at the factory.

C. All equipment that is to receive finish paint by the Painting Contractor, shall be cleaned by this Contractor and left ready to have surfaces prepared to receive paint.

1.25 RUBBISH REMOVAL

A. At the completion of each day's work, or when ordered by the General Contractor or the Architect, this Contractor shall remove from the property, all the rubbish or waste material belonging to him. Keep the job site free from accumulation of waste material and rubbish; premises must be maintained in a clean condition.

1.26 TEMPORARY STRUCTURES

A. This Contractor shall provide, on the premises and where directed by the Architect, shall maintain in good condition, and shall remove when directed, suitable and substantial watertight sheds in which he shall store all his materials and equipment.

1.27 TEMPORARY SERVICES

A. All water, electricity, fire protection and sanitary facilities required for safe and efficient construction during normal working hours shall be furnished in accordance with the General Requirements.

1.28 TESTS

A. Furnish all labor, materials, instruments, supplies and services and bear all cost for the accomplishment of the tests herein specified. Correct all defects appearing under test, repeat the tests until no defects are disclosed and leave the equipment clean and ready for use.

B. Perform any tests, other than herein specified, which may be required by legal Authorities or by Agencies to whose requirements this work is to conform.

C. Dispose of test water and wastes after tests are complete, in a manner satisfactory to the Architect and in accordance with governing regulations.

1.29 EQUIPMENT ACCESS REQUIREMENTS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the Drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels in walls and ceilings at locations indicated on the Drawings, or as required to permit access for adjustment, removal and the replacement and servicing of all equipment, and all other items requiring maintenance and adjustments. Access panels shall be installed by the General Contractor.

C. Coordinate the exact location of access panels in all finished spaces with the Architect.

1.30 MOTOR CHARACTERISTICS

A. Unless otherwise indicated, motors for equipment specified under this Section shall be furnished and installed by the Plumbing Contractor and shall be as follows:

1. Motors 1/3 HP and smaller shall be wound for 120 volts, single phase, 60 cycle AC service.
2. Motors 1/2 HP and larger shall be wound for 480 volts, three phase, 60 cycle, A.C. service. See equipment schedules and Electrical Specifications. Motor power factor shall be a minimum of 0.85. Motors shall be the high-efficiency type.

B. Unless otherwise specified, all motor starters shall be furnished and installed by the Electrical Contractor.

1.31 WIRING DIAGRAMS

A. This Contractor shall furnish wiring diagrams for all equipment furnished under this Section for which wiring is to be installed by the Electrical Contractor.

1.32 CROSS CONNECTIONS

A. No plumbing fixtures, devices or piping shall be installed which will provide a cross or interconnection between a water distributing supply and the drainage system.

1.33 CLEANING, FLUSHING AND TESTING

A. All equipment and piping, including all traps and cleanouts, shall be cleaned to the satisfaction of the Architect.

B. Coordinate all start up, operation and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification Section 019100.
1. “Contractors’ tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specification, Section 01 91 00, for further details.”
2. “System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and

documented by the Commissioning Agent. Refer to Commissioning Specification, Section 01 91 00, for system verification tests and commissioning requirements."

C. The entire water piping system shall be sterilized in accordance with the following:

1. The entire water distribution system including all cold water, hot water, hot water return, non-potable hot and cold lines, chilled water lines, etc., shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The chlorinating materials shall be either liquid chlorine, or calcium hypochlorite, or chlorinated lime. The sterilizing solution shall be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million, unless otherwise directed.

D. After construction is complete, at least four (4) weeks prior to occupancy, the domestic water system of the building shall be tested by a state-approved firm for the level of lead. The system shall be tested at a minimum of five (5) locations in the building, as directed by the Board of Health. Testing shall be done after system has been chlorinated and all fixtures have been thoroughly flushed for at least three (3) days. A written report of the test results shall be provided to the Owner within seven (7) days of the test. All costs associated with this testing and flushing shall be included in this Contractor's base bid price.

1.34 PROCEDURE FOR TESTING

A. This Contractor shall perform all tests in accordance with Paragraph 1.28 of this Section of the Specifications.

B. Partial tests shall be made, as required, by the progress of the work.

C. Test all piping and connections and make watertight before applying insulation and before concealment, as outlined in the following:

1. Sanitary System, Kitchen Waste, Acid Waste System and Storm System Piping
   a. All sanitary, kitchen waste, acid waste and storm piping shall be tested with water and proved tight to the satisfaction of the Architect and/or Plumbing Inspector before piping is covered and fixtures connected.
   b. Before the installation of fixtures and traps, close all openings of system and fill piping with water to roof and allow to stand for at least 30 minutes until a thorough inspection has been made, after which, if the lines prove tight, the water shall be drawn off and trenches backfilled and fixtures connected.
2. Water Systems
   a. All water piping shall be tested to a hydrostatic pressure of 150 psig. All piping shall be proved tight at this pressure before trenches are backfilled. Water piping, if in any way concealed by structural work, shall be tested to the aforesaid pressure and proved tight before pipes are concealed. This test pressure shall be held for a period of not less than one (1) hour. The Plumbing

Contractor shall make all repairs and alterations in the piping systems necessary to meet the test.

3. Gas Piping System
   a. All gas piping shall be tested in accordance with rules and regulations of the Massachusetts Gas Code and the National Fuel Gas Code (NFPA 54). In no case shall the tests be less than the following: Test gas piping at not less than a 12" column of mercury and piping shall hold tight for a period of two hours.

1.35 COMMSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. This contractor shall assist and support the CA as necessary in accordance with the requirements of specification section 01 91 00 – COMMISSIONING.
   1. “Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Tenant’s and Building Owner’s operation and maintenance personnel, is required in cooperation with Tenant’s and Building Owner’s Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Specification, Section 01 91 00, for detailed commissioning requirements.”

PART 2 PRODUCTS

2.1 INSTALLATION REQUIREMENTS

A. This Contractor shall comply with all the rules, Codes, Ordinances, regulations and requirements of all legally constituted Authorities having jurisdiction over the whole or any part of the work herein specified. Regulations supplement this Specification and shall take precedence in any case of conflict.

B. All equipment and materials furnished in connection with the installation shall be new and furnished in accordance with the requirements of the standards outlined in Paragraph 1.7 and they shall be of the best grade and quality of their respective kinds, free from natural, manufacturing or construction flaws, defects or irregularities and finish, fittings and workmanship shall be equal to the highest commercial grade.

C. Castings of all metals, of all kinds, shall be clean, smooth, close grained, of uniform thickness and free from all defects such as sandholes, blisters or cracks.

D. Before the installation will be accepted, the Plumbing Contractor shall have every portion of his work in a first-class working condition.

E. Where installing any of the apparatus herein called for, sufficient clearance shall be allowed to permit the removal and replacing of parts that may require future removal for repairs and replacement.

2.2 PIPE AND FITTINGS

A. Soil, Waste, Kitchen Waste, Vent and Storm Piping

1. Piping materials for sanitary and storm systems inside the building, above the floor slab, including soil, waste and vent piping, unless otherwise noted, shall be standard weight coated hubless cast iron equal to "no-hub" system. Pipe, fittings, couplings and gaskets shall be manufactured in strict accordance with the Cast Iron Soil Pipe Institute's Standard No. 301 and approved for use in Massachusetts. The pipe shall be cast in one piece and with gasket positioning lugs. The pipe shall be legibly marked on the barrel with the manufacturer's name and/or trademark.
2. Piping material for sanitary and storm systems below the floor slab or below grade shall be service weight cast iron soil pipe with hub joints, coated with tar and asphaltum.
3. Vent piping 2" and smaller shall be standard weight galvanized steel or wrought iron with screwed fittings. Waste pipe above ground may be Type "M" copper tubing with solder joint sweat drainage fittings.
4. Indirect waste piping shall be Type "K" copper tubing with sweat solder joint drainage fittings.
5. Urinal branch and fixture wastes shall be of cast, high silicon iron soil pipe and fittings with caulked joints of acid-proof rope packing.

B. Acid Waste and Vent Piping

1. Material for use above the floor slab shall be Schedule 40 polypropylene pipe with mechanical joint fittings. Piping below the floor slab and outside the building shall be Schedule 40 polypropylene with electrically fused joints and fittings. All polypropylene pipe shall be flame retardent.

C. Domestic Water, Chilled Water, Non-potable Water and Emergency Shower Water Piping

1. All water piping inside the building, except as hereinafter specified, shall be Type "L" hard-drawn copper tubing, as manufactured by Bridgeport Brass, American Brass, Revere Copper and Brass Company, or equal, with solder joints, seamless cast bronze or wrought copper fittings. Water piping buried underground shall be Type "K" soft-temper copper tubing with compression-type cast bronze fittings.
2. Piping for connections between valves and equipment shall be chrome-plated seamless red brass pipe, iron pipe size, containing not less than 85 percent copper and threaded brass fittings, with flat bands, as manufactured by Crane Company, Walworth, Grinnell, Milwaukee or equal.

D. Gas Piping and Gas Train Vent Piping

1. Gas piping and gas train vent piping shall be Schedule 40 steel or wrought iron complying with ANSI Standard for Wrought Steel or Wrought Iron Pipe, B36.10-1970. A suitable drip or condensation pocket shall be installed at all points in accordance with the requirements of all applicable Codes.

2.3 JOINTS AND COUPLINGS

A. Soil, Waste, Kitchen Waste, Vent and Storm Piping Joints

1. Couplings on all hubless cast iron piping shall consist of a stainless steel shield, band and tightening device, and a neoprene gasket assembled at the factory as a complete unit. Couplings shall be marked with manufacturer's name and number and shall meet ASTM C564 Specifications.
2. Joints for service weight cast iron pipe shall be made with resilient rubber gaskets.
3. All joints in threaded pipe shall be American National taper screw threads. Apply graphite and oil compound to the male threads only.
4. Joints between steel, wrought iron and cast iron shall be made with Manhoff Fitting screwed into threaded pipe and caulked into the cast iron pipe.
5. Every connection between drainage pipes and water closets, floor outlet service sinks, pedestal urinals, and earthenware trap standards or other fixtures with floor outlet, shall be made with brass, wrought copper, hard lead, iron or plastic flanges that are caulked, soldered or screwed to the drainage pipe. The fixture shall be bolted to the flanged connection, with an approved gasket, washer or setting compound between the fixture and the flange. Only brass or stainless steel nuts and bolts shall be used. The floor flange shall be fastened to a structurally firm base. The use of commercial putty or plaster as a setting compound is prohibited.

B. Acid Waste and Vent Piping Joints

1. Joints in acid waste and vent piping above the floor slab shall be mechanical-joint type with cut grooves, a sealing ring and appropriate fitting.
2. Joints in acid waste and vent piping below the floor slab shall have socket-type fittings, compatible with the piping and have a heavy gauge resistance wire molded into them. All joints shall be electrically fused for a complete seal.

C. Domestic Water, Chilled Water, Non-potable Water and Emergency Shower Water Piping Joints

1. Copper tubing and sweat fittings shall be assembled with 95-5, lead free, tin and antimony solder composition with a 1000EF melting point and a non-corrosive flux.
2. All copper piping 1-1/2" and larger shall have all tubing and fittings tinned prior to assembly.
3. Joints between copper tubing and iron pipe or at connections to tanks shall be made with a combination iron and brass flange with composition gasket and iron bolts.

D. Gas Piping Joints and Gas Train Vent Piping Joints

1. Joints in gas piping and gas train vent systems shall be made with malleable iron fittings and tape for pipe 3" and smaller. Pipe larger than 3" shall have welded joints, conforming to ANSI B31-2 Code for Pressure Piping, Chapter 5, API Standard 1104 and ASME Boiler and Pressure Vessel Codes, Section 9.

2.4 VALVES

A. General

1. Furnish and install valves, where indicated on the Drawings or specified, so located that they may be operated, repaired or replaced with a minimum effort and repacked under pressure.
2. The basic system of valves (i.e., gate, globe, check for water service) shall be one manufacturer.
3. Valves shall be Apollo, Jenkins, Walworth or equal.

B. Water System Valves

1. Furnish and install valves, where indicated on drawings or specified, so located that they may be operated, repaired or replaced with a minimum effort and repacked under pressure.
2. The following list of valves is intended only as a guide for type and quality to this Contractor:

Ball Valves	3" and smaller	Apollo #70-200
Ball Valves	4" in size	Apollo #78-255
Gate Valves	4" and larger	Jenkins #677-A
Balancing Valve		Apollo #70-200 with memory stop
Check Valves	3" and smaller	Jenkins #4093
Drain-Off Valves		Apollo #78-204

3. All fixture supplies and supplies to equipment not already furnished as such shall have angle or straight compression stops, unless otherwise specified.
4. Drain valves shall be installed to drain the water from all sections of the hot water, hot water return and cold water piping. Furnish and install 1/2" all brass plug cocks with hose connections on each drain.

C. Gas System Valves

1. Gas cocks shall be furnished and installed at connection to each piece of equipment, at each riser and where shown on the Drawings. Gas cocks shall be brass body tee handle types with Boston Key, manufactured in accordance with the local gas company requirements.

2.5 PIPE HANGERS, SUPPORTS, CHANNELS AND SEISMIC RESTRAINTS

A. All piping shall be rigidly supported from the building structure by means of approved hangers and supports. Pipes shall be supported so as to maintain the required grading and pitching of lines, to prevent vibration and to secure piping in place; they shall be arranged so as to provide for proper expansion and contraction of pipe.

B. Spacing of hangers for horizontal piping shall be in accordance with the following:

1. Cast Iron Soil Pipe - 5'-0" at the hubs for 5' lengths, and for 10' lengths use 1 hanger at the hub and 1 at mid-point of the length. On "no-hub" pipe, install additional hangers on each side of each joint.
2. Copper Tubing - 6'-0" o.c. for 1-1/4" and smaller. 10'-0" o.c. for 1-1/2" and larger.

3. Threaded Steel Pipe - 10'-0" o.c.
4. Acid Waste and Vent System Pipe - 4'-0" for pipe 2" and smaller and 5'-0" for pipe 3" and 4" in size.

C. If Codes having jurisdiction require closer spacing, the hanger spacing shall be as required by Code in lieu of the foregoing. Provide hangers at all changes in direction and on both sides of concentrated loads (valves, strainers, regulators, etc.).

D. Hangers shall be adjustable clevis hangers. Hanger rods shall have machine threads. Malleable iron brackets of approved type shall be used along the walls.

E. Hangers shall be Grinnell Company, Carpenter and Patterson or Fee and Mason.

F. Wire and strap hangers will not be permitted in this installation.

G. Friction clamps shall be installed at the base of all plumbing risers and at each floor.

H. Where three or more pipes are running parallel, gang type hangers may be used in lieu of the aforementioned clevis hangers. These hangers shall be sized to provide the insulation protectors as hereinafter specified. Separable saddles shall be used for each pipe on gang hangers. Where saddle slips are installed for uninsulated copper piping, they shall be constructed of 16 gauge (minimum) copper.

I. Field painting or spraying of hangers, rods and nuts in lieu of copper plating will not be acceptable.

J. All vertical lines, drops and runouts, including insulated pipes, shall be supported by split-ring extension type hangers or equal. These hangers shall be copper-plated when used on uncovered copper tubing. Supports on insulated piping shall be sized to fit the outside diameter of the pipe insulation. Hangers shall be placed in the horizontal line near the riser and at ten foot (10') intervals or at each floor slab.

K. All horizontal piping shall be suspended from the building by mild galvanized steel rod connecting the pipe hanger to inserts, beam clamps, angle brackets and lag screws, as required by the building construction, in accordance with the following:

PIPE SIZE (inches)	ROD DIAMETER (inches)
3/4 - 2	3/8
2-1/2 - 3-1/2	1/2
4 - 6	3/4
8 - 10	1

L. Hanger rods for other installations shall be sized in accordance with recommended load capacities of Specification ASTM A107.

M. All hangers on insulated lines shall be sized to fit the outside diameter of the pipe insulation. Provide pipe covering protection saddles at all hangers on insulated lines of sheet metal, 18 gauge, and twelve inches (12"), minimum length, and shall cover 180 degrees of arc (lower quadrants) on the covering at all hangers on insulated piping systems.

N. Remove rust from all ferrous hanger equipment immediately after erection.

O. Miscellaneous trapeze hangers for pipe supports with inserts and steel for interior plumbing stack and riser supports indicated shall be provided by this Contractor.

P. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional support after these items are removed.

Q. All factory fabricated channels with related accessories for piping supports shall be Unistrut Corporation or approved equal. Channels and fittings shall be constructed of bonderized steel, coated with a corrosion-resistant primer and ovenbaked. All other related accessories (nuts, bolts, rollers, washers, couplers, springs, etc.) shall be electro-galvanized finished.

R. All piping installed under this Section of the Specifications shall be independently supported from the building structure and not from piping, ductwork or conduit of other trades. All supplementary steel, including factory fabricated channels required to meet the requirements specified herein, shall be furnished and installed by this Contractor.

S. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building code. This Contractor shall submit one (1) copy of shop drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet state seismic code requirements. Cable provided for seismic systems shall be color coded and pre-stressed.

2.6 ACCESS PANELS

A. Furnish access panels for installation by the General Contractor, in walls and non-accessible ceilings, at locations as required to permit access for adjustment, removal and replacement of all equipment, such as valves, traps, vacuum breakers, and all other items requiring maintenance and adjustment.

B. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that the junction can be easily reached, and the size shall be sufficient for this purpose (minimum 16" x 16"). When access panels are required in corridors or other finished areas, they shall be located as directed by the Architect.

C. Panels shall be of the types specified in Section 083100 and shall be set square and flush in cooperation with the Subcontractors for other Sections of the Specifications. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of concrete masonry units.

D. Access panels Shop Drawings shall be submitted to the Architect for approval.

2.7 PIPE SLEEVES

A. General

1. All pipe sleeves shall be furnished and set by this Contractor. Their location and setting shall be carefully coordinated with the requirements or limitations of the structural member they are passing through. Any conflict arising shall be solved by utilizing the best trade practices.

B. Sleeves and plates shall be black steel, Schedule 40, in accordance with A.S.T.M. Specifications A-120.

C. They shall be provided at all joints where pipes pass through concrete or masonry. They shall be sized so as to provide for pipe covering and for lateral expansion.

D. The ends shall be flush with the surfaces, except in floors, where it is possible for water to accumulate, such as toilets, janitor's closets, etc., in which cases, they shall terminate one inch (1") above the finish floor.

E. Where pipes pass through partitions, ceilings and furring (plaster and glazed tile), furnish and install No. 24 gauge galvanized iron sleeves, over which furnish and install cast metal floor plates of the escutcheon type, designed to cover the sleeves and to remain in permanent position.

F. “This contractor shall be responsible to review all firestopping of all piping and related components for completeness. All firestopping materials and installation will be by the general Contractor under Section 078400.”

G. Furnish labor to set and fasten all sleeves before the floors and walls are finally constructed.

H. Provide chromium-plated escutcheon plates at all exposed locations in finished rooms where pipes pass through walls, floors and ceilings.

2.8 INSULATION

A. All water piping, all storm piping (horizontal and vertical) and all equipment installed under this Contract shall be covered as follows:

Piping or Apparatus	Insulation
All cold water, hot water, hot water return, storm, chilled water, non-potable cold water, non-potable hot water, tempered emergency shower supply and return water piping.	I.P.S. ½” to 6” – 1” thickness, 8” and larger – 1-1/2” thickness – both of fiberglass, heavy density, snap-on type
All valves and fittings on insulated lines and underside of roof drain bodies	Pre-molded PVC covers packed to 1” thickness with fiberglass
All trap primer piping and cold water and hot water piping below slab or in masonry walls	¾” closed-cell neoprene insulation

All supplies and wastes associated with handicapped lavatories	Modeled closed-cell vinyl insulation equal to Handi-Lav-Guard Model #103

B. Apply all insulation over clean, dry surfaces with all joints firmly butted together. Perform all tests prior to covering.

C. All fiberglass insulation shall be furnished with factory-applied, all-purpose, vinyl-coated and embossed vapor barrier laminate with pressure sealing lap adhesive seam. Openings, joints, and end strips shall be sealed against moisture penetration with vapor barrier cement.

D. Insulation shall be as manufactured by Gustin-Bacon Manufacturing Company. Owens-Corning Fiberglass Corporation, or Johns-Manville, and shall be applied by skilled insulation mechanics employed by an insulation contractor.

E. All insulation shall run continuously through walls, floors and ceilings.

2.9 CLEANOUTS

A. Cleanouts shall be installed where indicated on the drawings and/or where required in soil, waste, acid waste and storm pipes. Cleanouts shall be installed at the base of all risers and at each change of direction. In storm system, install cleanouts same as for soil or waste piping or dandy cleanouts before going below grade.

B. Cleanout plugs shall be heavy cast brass of the screwed type, full size up to and including four inches (4").

C. Cleanouts shall be same size as pipe for piping up to four inches (4") in size and not less than four inches (4") for piping larger than four inches (4").

D. For piping running under floor slab, cleanouts shall be brought up to just under the floor slab level.

E. Access cover for concrete floor type cleanouts shall be J.R. Smith 4043 bronze top; tile floor type shall be J.R. Smith 4163; carpeted floor type shall be J.R. Smith 4043-Y.

F. Access to cleanouts in walls shall be provided by an access panel.

G. All cleanout access covers shall be manufactured by J.R. Smith, Zurn or Josam.

2.10 TRAPS

A. Furnish and install traps with cleanouts on all fixtures and equipment requiring connection to the sanitary system of the same size and material as the pipe in which they occur.

B. Traps installed on threaded pipe shall be recessed drainage pattern.

C. Fixture traps shall be self-scouring and shall have no interior partitions except where such traps are integral with the fixture. Slip joints or coupling may be used on the trap inlet or within the trap seal of the trap if a metal-to-metal ground joint is used. Each fixture trap, except a trap that is cast integrally or in combination with the fixture in which the trap seal is readily accessible or except when a portion of the

trap is removable for cleaning purposes, shall have an accessible cleanout plug of ample size that is protected by the water seal.

D. Fixture traps shall be made of cast brass with wall thickness of not less than 0.1 inch. All exposed traps shall have a polished chrome finish.

E. Strainers, C.O. plugs, tailpieces, waste arms, and overflows and any other similar fixture to trap connection when of metal, shall be made of brass or other approved non-corrosive metal, not less than 17 gauge thickness.

F. Traps shall be set level with respect to their water seals.

2.11 UNIONS AND NIPPLES

A. Union connections installed on brass pipe two inches (2") in diameter and smaller shall be brass composition "E" in strict accordance with Federal Specification WW-U-516.

B. Piping shall be installed with unions properly spaced to permit alterations and repairs.

C. All connections between copper tubing and galvanized tanks or piping shall be made with dielectric unions.

D. All close and shoulder nipples shall be of corresponding materials as the pipe and shall be extra heavy design.

2.12 SHOCK ABSORBERS

A. Furnish and install, where shown on the Drawings or as required by Code, shock absorbers properly sized and in accordance with Plumbing and Drainage "Standard P.D.I. WH201." These units shall be equal to the Smith "Hydrotrols" type units. Shock Absorbers by Josam, Zurn or Watts are acceptable.

B. All shock absorbers must be located behind access panels or in readily accessible areas.

C. Installation of shock absorbers shall conform to manufacturer's recommendations.

2.13 VACUUM BREAKERS

A. Approved vacuum breakers shall be installed with any plumbing fixture or equipment in which the potable supply outlet may be submerged and which cannot be protected by the minimum air gap. This includes all fixtures with hoses or a means for attaching hoses.

B. All vacuum breakers shall be certified by a recognized testing laboratory acceptable to the Administrative Authority.

C. Vacuum breakers shall be installed with the critical level at least six inches (6") above the fixture they serve and on the discharge side of any control valve.

2.14 PIPING ACCESSORIES

A. Vacuum reliefs shall be Watts Regulator Company #36 or approved equal.

B. Thermometers shall be 4-1/2 inches in diameter, and angle with a range of 40°F. to 240°F., as manufactured by Albert A. Weiss and Son, Inc. Include thermometer well.

C. Pressure and temperature relief valves shall be ASME Rated, temperature relief 210°F., pressure relief 125 psi, double Btu rated, self-closing, as manufactured by Watts Regulator Company or approved equal.

D. Pressure gauges shall be four inches (4") in diameter with a range of 0 to 150 psi, as manufactured by U.S. Gauge.

2.15 VENTS THROUGH THE ROOF

A. All pipes extending through the roof for the sanitary or waste systems or acid waste system shall be the same material as that piping system. Vents shall be of sizes indicated on the Drawings and extend at least 18 inches above the roof, ending in the top of pipe, which will be flashed by the General Contractor. Any vent pipe within 25'-0" of an outdoor air intake shall extend a minimum of 2'-0" above the air intake.

2.16 DRAINS

A. Drains shall be provided as indicated on the drawings. Furnish and install all floor drains and roof drains. Coordinate installation of all flashing collars of roof drains with the Roofing Contractor. Plumbing Contractor shall be responsible for the proper location of the various sizes and types of drains furnished by him.

B. Drains in waterproof floors and areas shall have galvanized iron clamping rings with six (6) pound lead flashing to bond nine inches (9") in all directions. Drains shall be checked with Architect's drawings to determine depth of the flashing collar. Brass extension pieces shall be provided if necessary.

C. Floor drains shall be by J.R.Smith, Josam, Zurn and shall be equal to the following schedule:

1. Floor Drain "A" (General Areas) - J.R. Smith Figure 2010-A-P-050, cast iron body drain with flashing collar, adjustable, nickel bronze strainer head and trap primer connection. Unit to have four-inch (4") IPS outlet and deep seal trap.
2. Floor Drain ‘‘B’’ (Kitchen Area drain) - J.R. Smith Figure 3020, cast iron receptor with acid-resisting porcelain-enameled interior and nickel bronze rim and grate with flashing flange, lumaloy bottom strainer, four inch (4") IPS trap and outlet.
3. Floor Drain ‘‘C’’ (Kitchen Deep Drain) - J.R. Smith Figure 3061, cast iron receptor with acid-resisting, porcelain-enameled interior with nickel-bronze tops and four inch (4") IPS outlet and deep seal trap. Provide funnel drain with each unit, Figure 3581.
4. Floor Drain "D" (Dishwasher) - J.R. Smith Figure 3061, cast iron receptor with acid-resisting , porcelain-enameled interior with nickel-bronze, 3/4

grate and four-inch (4") IPS outlet with trap primer fitting and deep seal trap.

5. Floor Drain "E" (Science Rooms) - J.R. Smith Figure 3020, cast iron body drain with acid resistant coated interior and flashing collar. Drain to have four inch (4") IPS outlet with trap primer fitting and deep seal trap.
6. Floor Drain "F" (Mechanical Areas) - J.R. Smith Figure 2142 floor drain with cast iron body and cast iron tractor grate. Unit to have four-inch (4") IPS outlet with trap primer fitting and deep seal trap.

D. Roof drains shall be equal to the following schedule:

1. Roof Drain "A" - J.R. Smith Figure 1010-R-C-E-U-AD with Duco cast iron body, clamping collar, extension and aluminum dome. Outlet size as shown on the drawings.
2. Roof Drain "B" - J.R. Smith Figure 1010-R-C-E-U-AD with Duco cast iron body, clamping collar, extension and aluminum dome having ¼" mesh s.s. screen on dome. Outlet size as shown on the drawings.
3. Roof Drain "C" - J.R. Smith Figure 1015-R-C-AD with Duco cast iron body, clamping collar, adjustable extension and aluminum dome. Outlet size as shown on the drawings

E. Kitchen Trench Drains are to be furnished by the Kitchen Equipment Contractor and installed and piped by the Plumbing Contractor.

F. All floor drains and trench drains not provided with type primers shall be installed with "Trap Guard" insert as manufactured by ProSet Systems, Inc or equal.

2.17 WALL HYDRANTS, HOSE BIBBS AND ROOF HYDRANT

A. Furnish and install, where indicated on the Drawings and mounted at elevations indicated on the Drawings, wall hydrants equal to the following unit: J.R. Smith Figure 5609-NB, or equal, bronze hydrant with nickel/bronze face and hose connection having an integral vacuum breaker. Unit to have removable brass "T" handle.

B. Furnish and install, where indicated on the Drawings and mounted 18" above the finished floor, hose bibbs equal to the following unit: Hose Bibb "A" shall be a single temperature, solid bronze wall faucet with threaded spout and pail hook notch, Chicago Model No. 952 or equal.

C. Furnish and install, where indicated on the Drawings and mounted 18" above the finished floor, hose bibbs equal to the following unit: Hose Bibb "B" shall be a single temperature, solid bronze wall faucet with threaded spout and pail hook notch, Chicago Model No. 998-RCF or equal.

D. Furnish and install, where indicated on the drawings, roof hydrants. Roof hydrants to be Woodford Model RHY2 or equal. Each unit to have its drain piped with ½" copper tubing to the following locations.

2.18 EQUIPMENT CONNECTIONS

A. Certain equipment will be furnished and installed by others. They will be provided with strainers, tailpieces, waste valves and faucets. The Plumbing Contractor shall furnish and install traps, drains, stop valves, water piping and waste piping, as

specified herein, to all kitchen and science equipment.

B. All water, waste and vent piping which is located under counters or exposed at plumbing fixtures or food service equipment shall be chrome-plated or have chrome-plated cover tubes.

2.19 GAS SOLENOID VALVES

A. This Contractor shall furnish and install a gas solenoid valve (Solenoid Valve #1) to automatically shut off the supply of gas to the cooking equipment. Gas valve shall be of the type compatible with the hood's fire suppression system and shall be installed complete with all required cable, enclosure, pulleys, etc., necessary to connect valve to suppression system. System shall be tested several times, in the presence of the Owner, upon completion to insure proper operation.

B. “Downstream of the above outlined gas solenoid valve, this contractor shall install an ASCO, or equal Model 8214 gas solenoid valve (Valve #2) which shall be interlocked with the kitchen hood’s exhaust fan and detection system.”

C. Two (2) pairs of the above outlined valves shall be installed on this project. One (1) pair shall be in the School’s Kitchen, the other shall be in the Concession Building’s Cooking Area.

2.20 MASTER GAS VALVE BOXES

A. Master gas valve boxes shall be furnished and installed by this contractor, as detailed on drawings.

2.21 GAS SERVICE AND METER

A. Gas service up to the building, including meter, will be performed by the local Utility Company.

B. Cost of work will be backcharged to the Owner. The Plumbing Contractor must contact the Gas Company and coordinate the proper timing of the service and meter installation.

C. This Contractor shall coordinate with the Gas Company to insure proper installation of meter with regards to location.

2.22 INTERIOR GREASE INTERCEPTORS

A. This Contractor shall furnish and install three (2) interior grease interceptors; two (2) in the School’s Kitchen areas, which are complete in all respects. Interceptors shall be as manufactured by J.R. Smith, Zurn, Josam or equal.

B. Grease interceptors “A”, “B” shall be equal to J.R. Smith Figure 8350 grease interceptor with cradle, having acid-resistant epoxy inside and outside, and flow control fitting having a rating of 50 GPM and grease capacity of 100 pounds, bearing approval seal of the Plumbing and Drainage Institute. Interceptors to have three inch (3") non-submerged inlet and three inch (3") outlet connections, internal air-relief double wall deep seal code trap and removable baffles.

2.23 BACKFLOW PREVENTERS

A. Furnish and install a reduced pressure type backflow preventer (RPB-1) in the Mechanical Room in the make-up water supply to the HVAC system. Backflow preventer shall be of the size indicated on the Drawings. Device shall be equal to Watts Model No. 909.

B. Furnish and install reduced-pressure type backflow preventers in the non-potable water feeds to the science areas. Device RPB-2 (1" in size) shall be installed in the cold water supply. RPB-3 (1 in size) shall be installed in the hot water supply. Devices shall be equal to a Watts Model 909. There will be three location for this installation.

D. Furnish and install a reduced pressure type backflow preventer (RPB-4) in the Kitchen, in the water supply to the Ware washer. Backflow preventer shall be of the size indicated on the Drawings. Device shall be equal to Watts Model No. 909.

E. Furnish and install a double check backflow preventer (DCBP-1) on the outlet side of the tempering valve for the emergency shower water supply. Backflow preventer shall be of the size indicated on the drawings. Device shall be equal to a Watts Model 007.

F. Backflow preventers shall be by Watts, Apollo or Willkins.

G. Spare parts kits shall be provided with all backflow preventers and shall be attached to each unit.

H. This Contractor shall be responsible to file design data sheets, along with cuts of all backflow preventers, and obtain approval of same from the local Water Department and the Department of Environmental Protection.

2.24 TRAP PRIMERS

A. Furnish and install, where shown on the Drawings, automatic trap primers, of the pressure-drop type, complete with all associated piping, to all floor drains indicated on the Drawings. Trap primers shall be equal to Precision Plumbing Products - Oregon No. 1. Type ‘‘A’’ to have one-pipe distribution unit; Type ‘‘B’’ to have two-pipe distribution unit. Type “C” to have three-pipe distribution unit. Type “D” to have four-pipe distribution unit. Trap primers shall be installed in accessible locations or with access panels to permit servicing.

2.25 EXPANSION JOINTS AND LOOPS

A. Expansion joints for piping systems shall be located as required to prevent undue strain in the piping system, equipment or building structure.

B. Piping shall be so installed as to permit expansion and contraction degrees of anticipated installation area temperature.

C. Domestic Water Piping Systems

1. Provide expansion loops in all piping mains, where shown on the Drawings, of dimensions as indicated on the Drawings.

2.26 GAS FIRED HOT WATER HEATING SYSTEM

A. This contractor shall furnish and install, complete in every respect, two (3) hot water heaters, with balanced manifold piping, as detailed on the drawings. Each heater shall be equal to an PVI Commercial Gas Water Heater (Conquest) Model 80 L 130A-GCML
Input – 800,000 BTU/HR.
Recovery – 932 GPH per 100°F rise
Storage – 130 Gallons
120 VAC, 1 Phase, 60Hz, 11 amps

B. Each hot water heater shall be 96% thermal efficient, ANSI Z21.10.3@ 70 F to 140 F., Up to 99% thermal efficient at low fire. Heaters are equipped for direct combustion air connection. Maximum supply gas pressure to heater 10.5" W.C. Minimum pressure to be 3.5" W.C. Shall have an ASME working pressure of 150 psi, and stamped National Board, and listed by Underwriters Laboratories. Heaters has 15 year tank and heating surfaces warranty covering waterside and condensate corrosion, leaking, production of rust water, material defects and workmanship. Manufacturer's professional start-up service to be included.

C. Heater venting material, use category IV PVC, CPVC or ETL, UL, ULC or CSA listed stainless steel or Centrotherm Innoflue SW polypropylene vent. Minimum vent length is 5 eq. feet, maximum vent length varies by model number and vent diameter.

2.27 EMERGENCY SHOWER ELECTRIC HOT WATER SYSTEM

A. This Contractor shall furnish and install an electric hot water heater on a shelf, in the Acid Neutralization Rooms.

B. Electric hot water heater shall be as manufactured by Hubbell, or equal, with a 1.5 K.W. element, combined adjustable thermostatic control for 30° to 110°, set at 85°F and on/off switch. Heater to be equal to Model No. E06. Unit to have a 6 gallon cement-lined tank surrounded by foam insulation with a one (1) year warranty. Heater shall be installed complete with relief valve and all related components as required by the Massachusetts State plumbing Code.

2.28 DOMESTIC WATER TEMPERING SYSTEMS

A. This Contractor shall furnish and install, as detailed on the Drawings, one (1) domestic water tempering systems, equal to a Leonard Type TM-186-20015020PRV-RF-0-LTR with two (2) thermostatic mixing valves in a parallel installation, with integral check stops and wall support. Capacity shall be 182 GPM at 8 psig pressure drop with a range of 85E to 140EF. Units by Leonard, Powers, Lawler or equal are acceptable.

B. Units to be installed and piped in accordance with all manufacturer's recommendations.

C. This Contractor shall furnish, with each unit, one (1) complete repair kit to allow that mixing assembly to be totally rebuilt.

2.29 EMERGENCY SHOWER WATER TEMPERING VALVE

A. This Contractor shall furnish and install, as detailed on the Drawings, one (3) emergency shower water tempering valve equal to a Lawler Model No. 911, or equal, capable of delivering 60 GPM at a 30 psig pressure drop.

B. This Contractor shall furnish, with the unit, one (1) complete repair kit to allow the mixing assembly to be totally rebuilt.

2.30 HOT WATER CIRCULATORS

A. This Contractor shall install building circulator pumps where shown on the drawings. Pumps shall be Bell + Gossett, Taco or Armstrong. These units shall be rigidly mounted on iron pipe brackets. All wiring connections shall be done by the Electrical Contractor. Circulators shall be all bronze, capacity of all 120EF circulators shall be 15 GPM at 25 ft. head and shall be equal to a Bell & Gossett Model PR with a 1/6 HP, 120 volt, 1 phase motor. Capacity of the emergency shower circulator shall be 12 GPM at 14 ft. head and shall be equal to a Bell & Gossett Model PR with a 1/6 HP, 120 volt, 1 phase motor. Capacity of the 140°F circulator shall be 10 GPM at 10 ft. head and shall be equal to a Bell & Gossett Model HV with a 1/6 HP, 120 volt, 1 phase motor. Units shall have an adjustable aquastats to regulate operation of motor. Units shall be set to operate to provide a water temperature of 5EF below supply temperature.

B. This Contractor shall be responsible to balance each primary 120ºF return system to a flow of 10 GPM and each secondary 120F hot water return leg to a flow of 5 GPM and the 140ºF hot water return line to 10 GPM and each leg of the emergency shower system to 4 GPM. A final report indicating flows shall be provided. Flow control valves shall be used as balancing valves.

2.31 ACID NEUTRALIZATION SYSTEM

A. Acid waste neutralization system equipment shall be as manufactured by Orion Inc. or equal.

B. Install three (3) new complete system to service the Science classrooms in each zone. System shall be as shown on the Drawings and shall include the following:

1. Tank
   a. Tank shall be constructed of polypropylene with 1/2" thick walls, top and bottom. Cover to be flanged. Tank shall have 55-gallon nominal capacity. Tank to be 22.5" diameter, 33.5" high with 27" to outlet invert and 4" pipe connections. Tank to have 4 inch vent outlet connection.
2. pH Monitoring System
   a. P/N 738313, pH display and alarm with base unit, UL listed single sensor station, UL listed NEMA 4 enclosure, pH analyzer with user set Hi and Low alarm points and analyzer/sensor fault prewired with cord and plug for standard 120 vac, 15 amp outlet NEMA 5-15R, local alarm visual/audible indication 4-20mA output for remote indication, two 5A/120vac dry contacts for remote alarm

notification, one industrial 30 foot pH sensor with 1 ½ inch gas tight insertion fixture, factory calibrated with buffer 4 and 10 solutions,

U-Trap Assembly

a. U-trap assembly shall be manufactured of polypropylene pipe and fittings which have been joined by the heat fusion method. Tank side of trap is to have an extension section which will house the effluent pH probe. The purpose of this unit is to maintain a pocket of effluent which allows the probe to remain wet and insures that the flow will pass by the sensor. The inlet and outlet sides of the unit shall be provided with flanges.

3 Installation

a. All components and instrumentation system shall be furnished for installation from a single source.
b. The monitoring system shall be installed in strict accordance with the manufacturer's recommendations and drawings in compliance with job specifications and local plumbing codes.
c. Chemical feed tubing to be sleeved in secondary containment piping.
d. System calibration and start-up shall be included in the package provided by the manufacturer. The manufacturer shall also be responsible for conducting a training seminar for the site facilities people prior to the system being turned over to the Owner (minimum 12 hours).
e. The manufacturer, as part of his package, shall be responsible for making not less than three (3) visits during the first year of operation to check-up on the workability of the system. The manufacturer does not, however, take responsibility for the day-to-day operation of the system.
f. Manufacturer shall provide a point-to point wiring diagram drafted specifically for this project.
g. System supplier shall have a minimum of four (4) years experience in the design and installation of pH monitoring systems.

4 Warranty

a. All new components and instrumentation for the neutralization system shall be warranted against defects in workmanship and materials for a period of one (1) year from the date of delivery.

5 Insurance

a. Manufacturer shall include a Certificate of Insurance with their submittal, proving that they are insured as a manufacturer of such systems.

6 System Maintenance

a. Manufacturer shall be capable of providing a maintenance agreement with the Owner should they wish to enter into such an agreement.

7 System Wiring

a. Manufacturer shall be responsible for wiring all components of the system at the site. Wiring shall be done by a licensed Electrician and run in conduit per local codes. Only power wiring to the main and remote panels shall be provided under Section 260000.

C. Installation

1. All components and instrumentation for the neutralization systems shall be furnished, ready for installation from a single source.

2.32 PLUMBING FIXTURES

A. Furnish and install all fixtures including supports, connections, fittings and any incidentals to make a complete installation.

B. Supply escutcheons which are not furnished with plumbing fixtures.

C. Faucets and all exposed fittings shall be chromium-plated. All sinks (not lavatories) shall have flow restrictors for a maximum flow of 1.5 GPM.

D. Fixtures shall bear manufacturer's guarantee label or trademark indicating "first quality." Acid-resisting enameled ware shall bear the manufacturer's symbol signifying acid-resisting material.

E. Architect shall be final judge as to whether fixtures fulfill the requirements of the Specifications and as to whether they are of suitable quality.

F. Manufacturer - Fixtures shall be Kohler, American Standard or Toto. Flush valves to be Sloan-Royal, Toto or Delaney Flush Valve Company. Toilet seats to be Church, Beneke or Bemis. Carriers and drainage fittings to be J.R. Smith, Zurn or Josam.

G. The color of all fixtures shall be white.

H. Fixtures shall be in accordance with the following schedule:

P-1 Water Closet (Wall-Hung)
Kohler K4325, vitreous china, 1.28 gallon flush, siphon jet, elongated bowl, wall hung with 1-1/2" top spud.
Church 9500C white, solid plastic, open front seat, no cover, check hinge.
Sloan Royal “Optima” 111-1.28-ES-S flush valve, 1 inch screwdriver angle stop, vacuum breaker, cast brass set screw flange and C.P. I.P.S. nipple to wall and El-154 Transformer. Wiring between flush valve and transformer is the responsibility of the Plumbing Subcontractor, including box for valve connection.
Unit shall be set on an adjustable type combination fixture support and drainage fitting with foot support of type suitable to meet building construction and to set rim at 15" above floor.

P-1H Water Closet (Handicapped)
To be the same as Fixture P-1 outlined above, but to be mounted 17" to the rim of the fixture.

P-2 Urinal
Kohler K-4904-ET “Bardon” vitreous china, wall hung, urinal 1/8th GPF, (0.128 GPF), ¾” top spud, 14” extended rim, Water Saver compliant and with 2 inch wall outlet.
Sloan Royal Optima Model 186 ES-S, High Efficiency 1/8th GPF, (0.128 GPF), Flush valve, 1 inch screwdriver angle stop, vacuum breaker, cast brass set screw flange and C.P.I.P. nipple to wall and El-154transformer. Wiring between flush

valve and transformer is the responsibility of the Plumbing Sub-contractor, including box for valve connection. Mounted on floor-mounted chair carrier with foot support so rim is 24” above floor.

P-2H Urinal (Handicapped)
Urinal shall be the same as specified for Fixture P-2 except that mounting shall be 16 inches floor to rim and unit shall be set on a concealed chair carrier with foot support.

P-3 Lavatory
Kohler K-2030 "Greenwich" 20x18 inch vitreous china lavatory with front overflow, 8" faucet centers. Set on floor-mounted arm chair carrier so unit is 32" above floor to rim.
Chicago No. 116.101.AB.1 faucet with deck plate and 240.631.00.1 transformer. Wiring between faucet and transformer is the responsibility of the Plumbing Subcontractor.
K-7715 C.P. drain with integral grid strainer.
K-7607 (Pr) C.P. 3/8-inch angle supplies, with loose key stops, risers.
Powers Model e480 mixing valve with in-line checks installed in the supplies to the faucet fitting.
K-9010 C.P. 1-1/4 inch by 1-1/2 inch cast brass one-piece P-trap with cleanout.
K-9015 C.P. 1-1/2 inch by 6-inch IPS nipple to wall with cast brass set screw flange.

P-3H Lavatory (Handicapped)
Kohler K-2030 "Greenwich” 20 x 18 vitreous china lavatory, with floor-mounted concealed arm type carrier to set unit at 32" above floor.
Chicago No. 116.101.AB.1 faucet with deck plate and transformer. Wiring between faucet and transformer is the responsibility of the Plumbing Subcontractor.
K-13885 C.P. 1-1/4 inch offset drain with integral grid strainer.
K-7607 (Pr) C.P. 3/8-inch angle supplies, with loose key stops, risers.
Power Model e480 mixing valve with in-line checks installed in the supplies to the faucet fitting.
K-9010 C.P. 1-1/4 inch by 1-1/2 inch cast brass one-piece P-trap with cleanout.
K-9015 C.P. 1-1/2 inch by 6-inch IPS nipple to wall with cast brass set screw flange.
Concealed arm chair carrier with steel plate feet welded to uprights with one-piece threaded concealed arms.
All trim under lavatory to be insulated.

P-3B Lavatory System (Handicapped)
Bradley frequency model FL-2H-TMA-PT, ADA & TAS compliant lower station only, patented molded one-piece design with integral bowls, terreon solid surface material,, trap and transition cover enclose, includes capacitive sensing faucet, navigator thermostatic mixing assembly, 110-120 VAC plug-in adaptor to convert battery-operated S53-315 faucet. Provide floor mounted base carrier to support unit.

P-4 Bi-Level Water Cooler (Handicapped)
Halsey-Taylor Model HTHB-HACG8BLPV-WF, Filtered Bi-Level HAC green cooler with hydro-boost, bottle filler. Provide replacement filters 3 pack model number 55898C.
Two (2) 1-1/2 inch brass P-traps.
Two (2) 3/8-inch supplies with stops.
Provide mounting brackets.

P-5 Shower Units (Typical)

Shower valve/head assembly shall be a Symmons No. 1-100-X shower control with a 4-231- 1.5 GPM shower head. 2" stainless steel drain body cast integral with removable strainer plate made of stainless steel. Plumbing Subcontractor to set drain. Shower basin to be constructed in place by the General Contractor.

P-5H Shower Unit (Handicapped)
Shower basin to be constructed in place by the General Contractor. Plumbing Subcontractor to provide floor drain type "A" in each basin. Unit to have Symmons No. 1-25VT-FSB-X-48, pressure balanced shower valve with open-flow hand spray having 5'-0" of hose and 36-inch C.P. bar with adjustable slide and wall connection flange having a vacuum breakers. A 1.5 GPM glow restrictor shall be provided in the spray head.

P-6 Janitor's Sink
Fiat Mop Receptor Model TSB-3003, Terrazzo mop service basin with 6" drop front and stainless steel caps on all curbs.
Chicago No. 445-897-SRCXKCP manual faucet, wall mounted, adjustable arm, rigid vacuum breaker spout with 3/8" male hose thread and pail hook.
#832-AA hose and hose bracket.
#889-CC mop hanger.
Trap to suit.

P-7 Emergency Shower/Eyewash
Shower and Eye Wash units shall be equal to Guardian Model GBF2150, This Contractor shall furnish and install all piping between actuating arm, eyewash and shower head. Pipe to run in walls and above ceilings.

P-8 Sink
Elkay Model LRAD-2219, Single compartment, 22" x 19 X 6-1/2" deep, 18-8 nickel bearing stainless steel, top mount, drilled for 8" center faucet, 3 holes, self-rimming. Unit to have stainless steel cup strainer LR 35 and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 786-E3-319ABCP type faucet with swing spout and side spray. 2.2 GPM, 8 inch centers, 6 inch wrist blade handles.

P-9 Sink
Elkay Model LRAD-2219, single compartment,22" x 19" x 6-1/2" deep, 18-8 nickel bearing stainless steel, top mount, drilled for 8" center faucet, 3 holes, self-rimming. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 1100-317ABCP type faucet with swing spout, 4 inch wrist blade handles.

P-10 Sink
Elkay Model LRAD-2219, single compartment,22" x 19" x 6-1/2" deep, 18-8 nickel bearing stainless steel, top mount, drilled for 8" center faucet, 1 hole, self-rimming. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube
Chicago Faucet Model 116.103.AB. Electronic faucet, deck mounted single hole, Hy-Trronic Gooseneck dual beam infrared sensor, 0.5 GPM vandal proof non-aerating

spray outlet, single supply of tempered water, model 242.659.00.1, 12 volt AC transformer. Wiring between faucet and transformer is the responsibility of the Plumbing Subcontractor.

P-11 Service Sink
Elkay Model ESSB2520C, single wall service sink, 14 gauge, type 304 stainless steel, full length 12 inch high backsplash, furnished with wall hanger and stainless steel support brackets, LK173 cast iron P trap, LK907BR03L2H faucet, 4 inch lever handles, threaded hose connection with vacuum breaker and bucket hook.
C.P. 3/8-inch angle supplies with stops.
Provide LK 18B stainless steel strainer.

P-12 Double Bowl Scullery Sink
Elkay Model SS8248 double free standing scullery sink, 14 gauge, type 304 stainless steel, LK940VS07L2S faucet, 4 inch lever handles, vacuum breaker. LK 18B stainless steel strainer.
C.P. 3/8-inch angle supplies with stops.

P-13 Ceramic and Art Room Sinks
The sink, two (2) faucets and drain provide by General Contractor. This Contractor shall install sink, faucets, drain, trap and all related incidentals. Traps shall be furnished and installed by this Contractor. Sink to have J.R. Smith solid interceptor Model No. 8710, or equal.

P-13H Ceramic and Art Room Sinks (Handicapped)
The sink, faucet and drain provided by General Contractor. This Contractor shall install sink, faucet, drain, trap and all related incidentals. Trap shall be furnished and installed by this Contractor. Sink to have J.R. Smith solid interceptor Model No. 8710, or equal.
All trim under sink to be insulated. See Paragraph 2.8. Drain shall run parallel and tight to wall.

P-14 Sink (MS Science Classrooms)
Elkay Model DLR-2219, single compartment, 8-inch deep, 18 gauge sink driller for 8 inch center faucet. Unit to have grid strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
Trap shall be of the same materials as the acid waste system and shall be purchased from the supplier of that system.

P-14H (Handicapped)
Elkay Model DLR-2219, single compartment, 5-inch deep, 18 gauge sink driller for 8 inch center faucet. Unit to have grid strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
Trap shall be of the same materials as the acid waste system and shall be purchased from the supplier of that system.

P15 Washer Connection
Water connection shall be equal to Symmons Model No. W-602.

I. All fixtures and equipment shall be supported and fastened in a satisfactory manner. Where wall-hung fixtures are secured to masonry, they shall be fastened with 1/4-inch through bolts provided with nuts and washers and plates at back, except where chair carriers are specified. Bolt heads and nuts shall be hexagon and exposed bolts, nuts, washers and screws shall be chromium-

plated brass. Where secured to concrete walls, they shall be fastened with brass bolts or machine screws in lead sleeve-type expansion shields and shall extend at least 3 inches into solid concrete.

J. Where chair carriers are required, they shall be completely concealed in the building construction and shall rigidly support the fixtures from the floor. Chair carriers shall be securely fastened to the floor and be adjustable both vertically and horizontally, and shall support fixtures in such a manner that no part of the fixture will be supported by the wall or partition. All wall-hung water closets and urinals shall be supported on combination wall-hung drainage fittings and chair carrier complete with foot. These fittings shall be cast iron, vertical or horizontal type, fitted with face plate of the proper type to accommodate the fixture specified, furnished complete with necessary bolts, nuts and washers as well as connecting nipples of the proper length with gaskets for the closet connections.

2.33 HEAT MAINTENANCE CABLE

A. This Contractor shall furnish and install heat maintenance cable on the non-potable hot water piping. Contractor to refer to drawings for exact amount of heat maintenance cable to provide. Cable to start at discharge side of the backflow preventer and carry to the faucet outlet at each science room sinks.

B. Heating Cable shall be equal to Raychem “HWAT-Y2 Trace” as manufactured by Tyco Thermal Controls. Cable shall be installed tight to the pipe, below the insulation and in accordance with manufacturer’s recommendations. Cable shall be set to maintain 120º F water temperature using a Raychem *ECO Controller. All cables shall be connected to power supplies at the junction boxes indicated on the electrical plans.

2.34 EXTERIOR GREASE INTERCEPTOR

A. The Plumbing Contractor shall furnish and install, complete in all respects, an exterior grease interceptor constructed and installed as shown on Drawings. Precast, reinforced concrete unit shall be a 2,000 gallon tank. Unit shall be of 5,000 psi at 28-day concrete, have a design load of AASHTO-HS20-44, and have steel reinforcement of ASTM A-615-79, Grade 60. All joints shall be sealed with Acmelite Sealant.

B. Interceptor shall have an inlet and outlet tee, all of service weight cast iron. All tees shall extend a minimum of six inches (6”) above the flow line of the tank. Inlet tee shall extend to 36” off the bottom, outlet tee shall extend to 12” off the bottom and both shall be on the centerline of the tank, directly below their respective cleanout manholes. This Contractor shall be responsible to install all tees.

C. The interior of the grease interceptor shall have a plasticized liner field applied by this Contractor. Liner shall be equal to Sikagard 62, as manufactured by Sika Corporation and shall be installed in accordance with all the manufacturer’s recommendations.

2.35 GAS TRAIN VENT PIPING

A. This Contractor shall be responsible to furnish and install all required gas train vent piping for the boilers and hot water heaters. Piping shall be of same material and supported in the same manner as specified for gas piping. Vent piping shall run from components requiring same to the termination point noted on the drawings. Gas vent piping shall terminate with a turndown elbow with an insect screen.

2.36 WATER METER

A. This Contractor shall be responsible to connect to the new domestic water service stubs, provided by the General Contractor, six-inches (6") above the floor, in the school building and in the Concession Building. At point of connections, this Contractor shall provide a full size shutoff valve. This Contractor shall continue piping beyond, as shown on the drawings and as specified herein.

B. This Contractor shall be responsible to coordinate all work with the General Contractor to insure proper installation of service, location, sleeves, bracing and other items necessary to provide complete services. The cost of all labor and materials not included in the work done by the General Contractor, but required for a first-class installation, shall be the responsibility of this Contractor.

C. Water meters shall be furnished and installed by this Contractor in accordance with Beverly Water Department requirements. Meters shall have a bronze case and stainless steel shafts and bolts. Units shall read in cubic feet or gallons, as required, and have a remote reader. This Contractor shall be responsible to obtain all information pertaining to the required setting and piping arrangement required for the meters by the Beverly Water Department. All incidental items required for a complete, first-class installation by the Water Department shall be the responsibility of this Contractor.

2.37 EMERGENCY SHOWER SYSTEM SOLENOID VALVE/TIME CLOCK

A. This contractor shall furnish and install, where shown on the drawings a ball valve with an electric activator unit wired to a digital 24 hour time clock. All items, including time clock and all wiring between activator and time clock is the responsibility of the Plumbing Contractor. Unit shall be set to discharge for 10 seconds, every 12 hours.

2.38 VALVE TAGS, NAMEPLATES AND CHARTS

A. All valves on pipes of every description shall have neat circular brass valve tags of at least 1-1/2 inches in diameter, attached with brass hook to each valve stem. Stamp on these valve tags in letters as large as practical (1/2 inch minimum) the number of the valve and the service, such as "H.W.," "C.W.," for hot water and cold water respectively. The numbers of each service shall be consecutive.

B. All valves on tanks and pumps shall be numbered by 3-inch red metal discs with white numbers 2 inches high secured to stem of valves by means of brass hooks or small solid-link brass chain.

C. These numbers shall correspond to numbers indicated for valves on the RECORD DRAWINGS and on two printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information such as requiring the opening or closing of another valve or valves, when any one valve is to be opened or closed.

D. These printed lists shall be prepared in a format to meet approval of the Architect. Lists shall be framed under glass and hung as directed by the Architect.

E. Each water outlet on the water systems shall be additionally tagged as follows: Potable water outlets shall be identified by 3-inch diameter metal tags bearing the legend "SAFE WATER" in letters not less than 1/2-inch in height. Non-potable water outlets shall be identified by firmly-attached metal tags having the shape of a 4-inch equilateral triangle bearing the legend "WATER UNSAFE" in letters not less than 7/16-inch in height.

F. Nameplates, catalog numbers, and rating identification shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

2.39 PIPE IDENTIFICATION

A. All piping, shall have markers applied 25 feet on center and on both sides of wall penetrations and at access panel locations. Identification shall be applied after final painting of pipe covering is complete. Markers shall be applied after final painting of pipe covering is complete. All markers shall indicate direction of flow, description of pipe contents, and shall be of colors as specified herein.

B. All potable water shall be painted with 3” wide bands at 10’-0” intervals and on both sides of floor and wall penetrations, by the painting contractor.

C. Markers for piping up to six inches in diameter, including covering, shall be equal to Seton Type SNA snap-on markers. Markers for 6-inch diameter and larger, including covering, shall be equal to Seton Type STR strap-on markers with stainless steel spring fasteners. Markers on vertical lines shall be mounted as high as possible.

D. Pipe markers shall be as follows:

Piping System	Marking	Background Color
Non-potable Water	Unsafe Water	Yellow
Domestic Cold Water	Cold Water	Green
Domestic Hot Water	Domestic Hot Water	Green
Domestic Hot Water Return	Domestic Hot Water Return	Green
Waste	Waste	Blue
Vent	Vent	Blue
Storm	Storm	Blue
Gas	Gas	Yellow

PART 3 EXECUTION

3.1 OPERATION AND START-UP

A. This Contractor shall furnish all labor, materials and equipment necessary to place

the equipment into operation and then start and operate all systems to demonstrate the fitness of the installation.

B. Prior to start-up, the Plumbing Contractor shall check all systems for completeness, provide lubrication, clean and flush all piping and equipment, perform pressure tests, chemical treatment, and make all other adjustments necessary for start-up.

C. This Contractor may start portions of the systems as the work progresses; however, all systems which are normally operating simultaneously must be so operated upon completion of the work.

3.2 COORDINATION

A. The structure and its appurtenances, clearances and the related systems, such as plumbing, fire protection, heating, ventilation and electric, have been planned to be adequate and suitable for the installation of equipment specified under this Section. The Owner will not assume any increase in cost caused by differing requirements peculiar to a particular make or type of equipment and any such incidental cost shall be borne by this Contractor. He shall be responsible for the proper installation and location of his required sleeves, chases, inserts, etc., and see that they are set in the forms before the concrete is poured. He shall be responsible for his work and equipment furnished and installed by him until the completion and final acceptance of this Contract, and he shall replace any work which may be damaged, lost or stolen, without additional cost to the Owner.

B. In the event there is a conflict or inadequate space for the proper installation of Plumbing equipment, this Contractor shall prepare a scaled (1/4" - 1'-0" min.) composite sketch showing the building structure and all equipment and items affecting the installation, to clearly identify the areas of conflict. This Contractor shall submit four (4) copies of the sketch, along with a written explanation of the problem, to the Architect for his review and determination on what action to take to resolve the conflict.

C. It shall be the duty of this Contractor to furnish full information to all trades relative to the work they are to do in connection with work under this Section. This includes data for wiring, including wiring diagrams, equipment foundations, pipe connections, etc. furnished under other Sections.

3.3 PAINTING

A. This Contractor shall apply one (1) coat of anti-rust paint and one (1) coat of flat black enamel to all support steel, hangers and other steel or iron elements of the Plumbing System, furnished by him, which will be enclosed or above ceilings when the project is completed.

B. Paint shall be omitted from all items with a galvanized finish.

C. All surfaces to be painted shall be free of dirt, scale, rust, grease and oil. Rust spots are to be wire brushed. Ambient temperature shall be in accordance with paint manufacturer's requirements when painting is being performed.

D. This Contractor shall touch up, with spray paint, all scratched or damaged surfaces of equipment with factory finish. Spray paint shall be the same color and type as factory finish.

E. The Painting Contractor shall paint all mechanical equipment, enclosures, covers, panels, insulation, conduit and other equipment exposed to view, except factory finished items. Care shall be taken not to paint over equipment nameplates. This Contractor shall leave surfaces to be painted ready to receive paint. The Painting Contractor shall apply paint in accordance with the Painting and Finishing portion of this Specification. Colors shall be selected by the Architect.

3.4 PROTECTION OF SYSTEMS

A. Materials, fixtures and fittings shall be properly protected and all pipe openings shall be temporarily closed so as to prevent obstructions and damage. All plumbing fixtures (i.e., water closets, lavatories, and urinals) shall be boxed over and all other fixtures protected with pasted-on paper. Post notice prohibiting the use of the fixtures prior to completion. Take precaution to protect all materials.

3.5 SANITARY AND STORM DRAINAGE SYSTEMS

A. Sanitary, Waste, Kitchen Waste, and Acid Waste Systems

1. Provide complete interior and exterior sanitary, waste, Kitchen Waste drainage and acid waste systems up to 10'-0" off each building, or as indicated on the Drawings, connecting to all plumbing fixtures, floor drains and equipment.

B. Storm

1. Provide complete storm water piping systems, up to 10'-0" off the building, or as indicated on the drawings, connecting to all roof drains.

C. Indirect Waste Piping Systems

1. Furnish and install complete indirect waste piping systems, as indicated on the drawings, connecting to fixtures and equipment, discharging through an air gap into trapped floor drains or fixtures.

D. General

1. Soil, waste, Kitchen Waste, vent, acid waste, acid vent and storm piping shall be installed, as indicated on the Drawings, properly secured to the building structure. All piping above slab shall be secured with iron hangers. Extend to roof all lines of soil, waste and vent piping in stacks with all branches and fittings required and with extension through roof, as required by the Commonwealth of Massachusetts Plumbing Code. Where an end circuit vent pipe from any fixture or line of fixtures is connected to a vent line serving other fixtures, the connection shall be at least three feet (3') or sufficiently above the floor on which the fixtures are located, to prevent use of the vent line as a waste line.
2. All changes in pipe size and direction on soil connections and waste lines shall be made with Y's and 45-degree fittings or 45-degree combination fittings shall be used wherever possible. All offsets shall be made at an angle of not more than 45 degrees.
3. All fixtures and drains shall be separately trapped and all traps shall be vented, unless otherwise indicated on the drawings, for fixtures or drains in

battery vent systems.

4. This Contractor shall flush the sanitary and storm system piping with water in sufficient volume to obtain free flow through line. Remove all obstructions and correct all defects discovered.
5. All cast iron pipes shall be free from sand holes, cracks or other defects and shall be of uniform weight, size and thickness, installed concealed in finished areas, as required to provide adequate waste from fixtures, evenly pitched and properly secured with iron hangers.
6. All piping three inches (3") or less in diameter shall be installed with a pitch of not less than 1/4 inch per foot; larger than three inches (3") in diameter shall be installed with a pitch of not less than 1/8 of an inch per foot.
7. The building drains shall leave the building where shown on the Drawings, and shall be provided with a full four inch (4") cleanout accessible from the building interior.
8. Prior to commencement of work, this Contractor shall verify with the General Contractor all inverts and direction of lines leaving the building.
9. Furnish and install a complete system of vent piping to vent all stacks, fixtures, traps and appliances, as indicated on the Drawings and/or required to meet the Plumbing Code. All vent piping shall be concealed, where possible, with the horizontal pipe pitching back toward fixtures to allow condensation to drain. Vent stacks passing through the roof shall extend 18 inches above the roof, and shall be a minimum size of two inches (2") in diameter. The vent shall be located at least eight feet (8') back of roof edges (offset, as required).

3.6 WATER SYSTEMS

A. Provide complete water systems to service all fixtures, systems, equipment and points requiring water throughout the project. Systems shall include connection to water services, water meters, all valves, all piping, insulation, gauges, all control devices, equipment bases and all other related controls and accessories specified herein and/or indicated.

B. Installation

1. Branch lines from service or main lines shall be taken off the top of main as indicated, using such cross-over fittings as may be required by structural or installation conditions. All service pipes, fittings and valves shall be kept a sufficient distance from other work and not less than 1/2 inch between finished coverings on the different services.
2. Provide shock absorbers at hot water heaters and at all locations indicated on the Drawings. Provide access panels at all concealed shock absorbers.
3. Pipes shall be run parallel and graded evenly to drainage points. There shall be a 1/2 inch drain valve at each low point in piping so that all parts of the systems can be drawn off.
4. Provide valves on all risers to groups of fixtures and wherever shown on the Drawings. Valves in pipe spaces shall be made accessible by the use of access panels.
5. Cast brass or bronze unions shall be installed in the water system at the connections to all equipment so that they may be conveniently disassembled.
6. Pipe shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing.
7. Air chambers shall be provided at the top of supplies to each plumbing

fixture or series of fixtures, not protected by a shock absorber.

8. No piping shall be installed in a manner to permit back siphonage or any flow of water from sanitary or drainage systems into water service or distribution piping under any conditions.
9. Air gaps, open end of funnel drains and approved vacuum breaking devices shall be provided as required and as approved by the Inspector of Plumbing. Piping to hose end faucets or hose end fittings or any fixtures where water supply outlet is below the fixture overflow rim shall have vacuum breakers.
10. Where flanges are installed on the systems, red rubber gaskets shall be installed between each pair of flanges.
11. Heating of piping to eliminate the installation of fittings will not be permitted.
12. Piping systems shall be kept clean during all phases of work. Open ends of incomplete piping shall be protected to prevent the entrance of foreign materials.
13. Furnish and install a copper-plated friction clamp on all cold water supplies to each water closet.
14. Provide suitable means of thermal expansion for all hot water piping, using swing joints, expansion joints or expansion loops, and long-turn-offsets as required. Piping connections to equipment shall be provided with unions or flanges to permit alterations and repairs.

3.7 GAS DISTRIBUTION SYSTEMS

A. Provide complete gas distribution systems to service all equipment and points requiring gas throughout the project. System shall include all cooking equipment, boilers, make-up air unit, hot water heaters, science labs and all other equipment specified herein and/or indicated.

B. Installation

1. All gas piping shall be installed in accordance with the rules and regulations of the Massachusetts State Fuel Gas Code.
2. Gas piping shall be supported to pitch evenly toward drip pockets.
3. This Contractor shall be responsible to field paint all exterior gas piping with two (2) coats of grey enamel paint.

END OF SECTION

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SECTION 23 00 00
HEATING, VENTILATION AND AIR CONDITIONING

INDEX

PART 1 GENERAL 1
1.1 GENERAL PROVISIONS 1
1.2 GENERAL REFERENCES 2
1.3 SCOPE OF WORK 2
1.4 DEFINITIONS 4
1.5 VALVE TAGS, NAMEPLATES AND CHARTS 4
1.6 SHOP DRAWINGS 4
1.7 CODES, REGULATIONS AND PERMITS 5
1.8 INTENT 5
1.9 DRAWINGS AND SPECIFICATIONS 5
1.10 GIVING INFORMATION 5
1.11 OBTAINING INFORMATION 6
1.12 MATERIALS AND EQUIPMENT 6
1.13 REFERENCES 6
1.14 COORDINATION DRAWINGS 6
1.15 MOTORS AND STARTERS 7
1.16 TEMPORARY HEATING 7
1.17 OPERATIONS AND MAINTENANCE MANUALS 7
1.18 RECORD DRAWINGS 8
1.19 CONTRACT COST BREAKDOWN 8
1.20 GUARANTEE AND SERVICE 8
1.21 DEBRIS REMOVAL AND CLEAN-UP 8
1.22 COMMISSIONING REQUIREMENTS 8
1.23 EXAMINATION OF SITE AND DOCUMENTS 9
1.24 SEQUENCING 9
PART 2 PRODUCTS 9
2.1 ACCESS PANELS 9
2.2 AIR SEPARATORS 10
2.3 BOILERS 11
2.4 BREECHING AND CHIMNEY (DOUBLE WALL AL29-4C) 14
2.5 CABINET UNIT HEATERS 16
2.6 CHEMICAL TREATMENT 16
2.7 CHILLER (AIR COOLED) 17
2.8 CONVECTORS 22
2.9 DUCTLESS SPLIT FANCOIL SYSTEM 23
2.10 ENERGY RECOVERY UNIT (ERU-1 through ERU-8) 24
2.11 EXPANSION JOINTS 32
2.12 EXPANSION TANKS 33
2.13 FANS (CENTRIFUGAL) 33
2.14 FANS (DESTRATIFICATION) 33
2.15 FANS (ROOF) 35
2.16 FAN (FUME HOOD EXHAUST) 35
2.17 FANCOIL UNITS 37
2.18 FILTERS 38
2.19 FINTUBE RADIATION 39
2.20 FOUNDATIONS AND SUPPORTS 39
2.21 GRAVITY VENTILATORS 39
2.22 HOT WATER REHEAT COILS 40
2.23 INSULATION MATERIALS (GENERAL REQUIREMENTS) 40

2.24 INSULATION MATERIALS (EQUIPMENT) 41
2.25 INSULATION (PIPING) 41
2.26 INSULATION (SHEET METAL) 43
2.27 MAKE-UP AIR UNIT (INDIRECT GAS FIRED) 45
2.28 MOTORS 49
2.29 PIPE, HANGERS, SUPPORTS AND ANCHORS 50
2.30 PIPING MATERIALS 55
2.31 REFRIGERANT PIPING AND SPECIALTIES 57
2.32 PRESSURE GAUGES 58
2.33 PUMPS 59
2.34 RADIANT HEATING PANELS 60
2.35 REGISTERS, GRILLES AND DIFFUSERS 61
2.36 ROOFTOP AIR HANDLING UNITS 62
2.37 SHEET METAL WORK 70
2.38 SHEET METAL WORK (HIGH VELOCITY SYSTEMS) 73
2.39 SLEEVES, INSERTS AND OPENINGS 74
2.40 SOUND ATTENUATORS 76
2.41 STRAINERS 78
2.42 SUPPLEMENTAL SUPPORT SYSTEM 78
2.43 TERMINAL BOXES 79
2.44 THERMOMETERS 80
2.45 UNIT HEATERS 80
2.46 VALVES 81
2.47 VARIABLE FREQUENCY DRIVES 84
2.48 VIBRATION ISOLATION AND SEISMIC RESTRAINTS 90
2.49 WATER FLOW MEASURING DEVICES 100
2.50 WATER SYSTEM ACCESSORIES 100
2.51 AUTOMATIC TEMPERATURE CONTROLS 100
2.52 HOISTING MACHINERY AND EQUIPMENT 125
PART 3 EXECUTION 125
3.1 MATERIALS AND WORKMANSHIP 125
3.2 COORDINATION 125
3.3 COORDINATION DRAWINGS 126
3.4 PROTECTION AND CLEAN UP 127
3.5 OPERATING AND MAINTENANCE MANUALS 127
3.6 OPERATING INSTRUCTIONS 127
3.7 SYSTEM START-UP AND OPERATION 128
3.8 SYSTEMS IDENTIFICATION 129
3.9 SHEET METAL WORK REQUIREMENTS 130
3.10 PIPING SYSTEM INSTALLATION 132
3.11 PIPING SYSTEM FLUSHING AND CLEANING 134
3.12 PIPING SYSTEM PRESSURE TESTS 134
3.13 INSULATION APPLICATION REQUIREMENTS 135
3.14 SYSTEM BALANCING 137

END OF SECTION 146

SECTION 23 00 00
HEATING, VENTILATING AND AIR CONDITIONING
(Filed Sub-Bid Required)

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS shall be included in, and made a part of this Section.

B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:

Site Work Drawings: L xxx through L xxx inclusive.
Architectural Drawings: A xxx through A xxx inclusive.
Food Service Drawings: K xxx through K xxx inclusive
Structural Drawings: S xxx through S xxx inclusive.
Plumbing Drawings: P xxx through P xxx inclusive.
Fire Protection Drawings: FP xxx through FP xxx inclusive.
HVAC Drawings: H xxx through H xxx inclusive
Electrical Drawings: E xxx through E xxx inclusive.
Telecommunications Drawings: T xxx through T xxx inclusive

1. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section or by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
2. Refer to Section 01 23 00 - ALTERNATES, for alternates that may affect the scope of Work of this Section.

D. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____
SUB-BID FOR TRADE: TITLE.

2. Each Sub-Bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid deposit in compliance with MGL c149, Section 44B in the amount of 5 percent of Filed Sub-Bid.

E. Sub Sub-Bid Requirements: In accordance with Massachusetts General Law, Chapter 149, Section 44F, as amended, The Filed Sub-Bidder shall list in "Form for Sub-Bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that Sub-Trade require such listing.

1. This filed trade requires that the following classes of work be listed in under the conditions indicated herein:

a. SHEETMETAL WORK	2.42, 2.43, 3.9
b. INSULATION	2.28, 2.29, 2.30, 2.31, 3.13
c. AUTOMATIC TEMPERATURE CONTROLS	2.57

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General and Supplementary Conditions and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. Work Included: The scope of work consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of furnishing all labor, materials, equipment, plant, transportation, rigging, staging, appurtenances and services necessary and/or incidental to properly complete all heating, ventilating and air conditioning work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either, in the opinion of the Architect as being required, and includes:
   1. Gas fired hot water boilers and associated combustion air system and flue system.
   2. Hot water heating and chilled water cooling rooftop units and energy recovery units.
   3. Hot and chilled water supply and return piping distribution system and accessories.
   4. Hot and chilled water circulation pumps, expansion tanks, air separators and accessories.
   5. High efficiency air cooled chiller.
   6. Supply ductwork with associated terminal boxes, hot water reheats coils and supply registers and diffusers.
   8. Return and exhaust ductwork with associated grilles and registers.
   9. Refrigerant piping systems and accessories.
   10. Fintube radiation, cabinet unit heaters, convectors and horizontal unit heaters.
   11. Toilet exhaust and general exhaust systems.
   12. Kitchen hood exhaust system.
   13. Piping and ductwork insulation.
   14. Balancing, air and water.
   15. Automatic temperature controls.
   16. Chemical treatment.
   17. Furnish, erect and maintain staging and scaffolding, including mechanical hoisting and rigging equipment required for the performance of the heating, ventilating and air conditioning work.

B. The HVAC Subcontractor shall be responsible for all cutting and patching related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade affected.
   1. For coordination of cutting and patching, refer to Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION.
   2. For cutting and patching specifications, refer to Section 01 73 00, EXECUTION REQUIREMENTS.

C. Items to be Furnished Only: Furnish the following items for installation by the designated Sections:
   1. Access Panels
      a. Access panels for access to heating, ventilating and air conditioning equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

D. Items to be Installed Only: Install the following items as furnished by the designated Sections:
   1. SECTION 26 00 00 - ELECTRICAL
      a. Duct mounted smoke detectors.

E. Related Work: The following items of work are not included in this Section and are specified under the designated SECTIONS:
   1. DIVISION 1 - GENERAL REQUIREMENTS
      SECTION 01 31 00 PROJECT MANAGEMENT AND COORDINATION
      a. Coordination of cutting and patching.
      SECTION 01 73 00 - CUTTING AND PATCHING
   2. DIVISION 2 - SITE CONSTRUCTION
      a. Excavation, backfill, pumping and shoring.
   3. DIVISION 3 - CONCRETE
      a. Concrete bases and supports.
   4. DIVISION 7 - THERMAL AND MOISTURE PROTECTION
      SECTION 07 00 02 - ROOFING AND FLASHING
      a. Flashing for all roof penetrations.
   5. DIVISION 8 - DOORS AND WINDOWS
      a. Door louvers and undercut doors.
   6. DIVISION 9 - FINISHES
      SECTION 09 00 09 - PAINTING
      a. Field painting, except as noted otherwise. Field painting of radiation shall be done using the electrostatic method.
   7. DIVISION 8 - OPENINGS
      SECTION 08 90 00 - LOUVERS AND VENTS
      a. Exterior wall louvers.
   8. DIVISION 11 - EQUIPMENT
      SECTION 11 40 00 - FOOD SERVICE EQUIPMENT
      a. Kitchen equipment.
   9. DIVISION 21 - FIRE SUPPRESSION
      SECTION 21 00 00 FIRE SUPPRESSION
      a. Sprinklers and equipment.
   10. DIVISION 22 - PLUMBING
      SECTION 22 00 00 - PLUMBING
      a. Domestic water heaters.
      b. Town water make-up.
   11. DIVISION 26 - ELECTRICAL
      SECTION 26 00 00 - ELECTRICAL
      a. Power wiring except power wiring to variable air volume terminal units
      b. Starters and disconnects where not furnished integral with equipment.
      c. Emergency generator and related equipment.
      d. Wiring of smoke detectors.
      e. Wiring of Solid State Controller and wiring to associated destratification fans.
      f. Wiring of Solid State Controllers to respective exhaust fans.

F. The work of this Section is shown on Drawings numbered, M0.1 through M7.5.

1.4 DEFINITIONS

A. "HVAC" as used hereinafter in this SECTION shall mean "Heating, Ventilating and Air Conditioning."

B. "HVAC Subcontractor" as used hereinafter in this SECTION shall mean the "Heating, Ventilating and Air Conditioning Subcontractor," i.e., the filed bid subcontractor under this Section 23 00 00.

C. "Concealed" shall be defined as areas where piping is located in chases, shafts, pipe tunnels, and above furred ceilings.

D. "Underground" shall mean piping exterior to or within the building that is buried. All other piping shall be considered "exposed."

E. "Piping" shall mean, in addition to pipe, all fittings, valves, hangers, and other accessories relating to such piping systems.

F. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

1.5 VALVE TAGS, NAMEPLATES AND CHARTS

A. Furnish and install on each gate and globe valve, and on all automatic control valves used in this contract, a two-inch diameter brass tag with stamped numeral a minimum height of one-half inch painted white. The tags shall be attached to the valve handles or stem necks with brass hooks or chains and properly secured.

B. These numbers shall correspond to numbers indicated for valves on the Record Drawings and on two printed detailed lists. These printed lists shall state the numbers and locations of each valve and control and the section, fixture or equipment which it controls, and other necessary information such as requiring the opening or closing of another valve or valves, when any one valve is to be opened or closed.

C. These printed lists shall be prepared in form to meet approval of the Architect and shall be framed under glass.

D. Nameplates, catalog numbers and rating identification shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

1.6 SHOP DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 33 00, Submittal Procedures, for submittal provisions and procedures.

B. In accordance with Division 1, General Requirements, submit to the Architect for approval complete sets of detailed information consisting of manufacturers' bulletins, capacities, shop drawings, and parts lists of all material to be provided for this project.

C. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance

required. Unless noted otherwise, this is NOT a proprietary specification and it should be noted that “Or approved equal” applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an “approved equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.7 CODES, REGULATIONS AND PERMITS

A. All work done under this SECTION shall conform to the codes and regulations governing such work as set forth by the Massachusetts Department of Public Safety, the Massachusetts State Building Code and all local codes having jurisdiction.

B. Give notices, file plans, obtain permits and licenses, and obtain necessary approvals from authorities having jurisdiction. Deliver certificates of inspection to Architect. No work shall be covered before examination and approval by Architect, inspectors and authorities having jurisdiction. Imperfect or condemned work shall be replaced with work conforming to requirements, without extra cost to Owner, subject to the approval of the Architect. If work is covered before due inspection and approval, the HVAC Subcontractor shall pay costs of uncovering the installed work, whether it meets contract requirements or not.

C. Refer to Division 1, Section 01 41 00, Regulatory Requirements.

1.8 INTENT

A. It is not intended that the Drawings show every pipe, fitting, and appurtenance. All such parts necessary for the complete execution of the work, in accordance with the best practices of the trade and to the satisfaction of the Architect shall be provided whether these parts may have been specifically mentioned or not, or indicated on the Drawings.

1.9 DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are complementary each to the other, and any labor or material called for by either, whether or not by both, or necessary for the successful operation of any components shall be furnished and installed.

B. Before installing any work, verify that it does not interfere with the clearances required for other work. Installed work which interferes with existing necessary services shall be modified as directed by the Architect, at no additional cost to the Owner.

C. Be familiar with the Drawings and Specifications of all other trades to prevent interferences and assure complete coordination.

1.10 GIVING INFORMATION

A. Keep fully informed as to the shape, size and position of all openings and foundations required for all apparatus furnished under this SECTION and give full information to the General Contractor sufficiently in advance of the work, so that all such openings and foundations may be built in advance. Furnish all sleeves and supports herein specified, so the General Contractor may build same in place.

B. In the case of failure to give proper information as noted above, assume the cost of having necessary changes to the work made by the General Contractor.

1.11 OBTAINING INFORMATION

A. Obtain detailed information from the manufacturers of apparatus which is to be provided, for the proper methods of installation. Obtain all information from the General Contractor and other Subcontractors which may be necessary to facilitate the work and the completion of the whole project.

1.12 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished under this SECTION shall be new and of the best grade for the service intended. The manufacturers mentioned in the specifications are intended to indicate the quality desired. Any substitutions shall be reviewed by the Architect as herein provided by the "or equal" clause, in addition to meeting the limitations of space and capacity shown or specified. Re-built materials and equipment will not be accepted.

1.13 REFERENCES

A. National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Engineer.

B. Refer to SECTION 01420 - REFERENCES for schedule of references.

C. Reference Standards:

1. Reference herein to any technical society, organizations, group or body are made in accordance with the following abbreviations:

ADC	Air Diffusion Council
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air Conditioning & Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWG	American Wire Gauge
AWS	American Welding Society
FS	Federal Specifications
IEEE	Institute of Electrical and Electronic Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturer Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriters Laboratories, Inc.

1.14 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, the HVAC Subcontractor shall prepare and submit to the Engineer, Coordination Drawings showing the size and location of his equipment, ductwork and piping lines relevant to the complete system. He shall ensure that these drawings are compatible and correctly annotated and cross- referenced at their

interfaces.

B. Coordination drawings are for the Contractor's and the Engineer's use during construction and shall not be construed as replacing any shop or record drawings required elsewhere in these Contract Documents.

1.15 MOTORS AND STARTERS

A. Motors for all equipment under this SECTION shall be quiet in operation and shall be guaranteed to run without objectionable noise or vibration.

B. Motors smaller than one-half (1/2) horsepower shall be wound for 120 volts, single phase, 60 hertz.

C. Motors one-half (1/2) horsepower and larger shall be wound for 480 volt, 3 phase, 60 hertz.

D. Starters for all equipment shall be provided by the Electrical Subcontractor.

E. Voltages shown in Paragraphs B and C are typical unless otherwise noted.

F. All motors one horsepower and over shall be premium efficiency type.

1.16 TEMPORARY HEATING

A. Special reference is made to "Heating during Construction", Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

1.17 OPERATIONS AND MAINTENANCE MANUALS

A. Refer to SECTION 01 78 00 - CLOSEOUT SUBMITTALS, for submittal procedures pertaining to operating and maintenance manuals.

B. At least two (2) months prior to the time of turning over this contract to the Owner for Use & Occupancy or substantial completion, secure and deliver to the Architect three (3) complete indexed files containing approved operating and maintenance manuals, shop drawings, and other data as follows:
   1. Operating manuals and operating instructions for the various systems.
   2. Catalog data sheets for each item of mechanical or electrical equipment actually installed including performance curves, rating data and parts lists.
   3. Catalog sheets, maintenance manuals, and approved shop drawings of all mechanical or electrical equipment controls and fixtures with all details clearly indicated.
   4. Names, addresses and telephone numbers of repair and service companies for each of the major systems installed under this Contract.
   5. Copies of all service contracts provided for the guarantee period.
   6. Copies of all equipment and system warranties.

C. Non-availability of operating and maintenance manuals or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the Owner until such time as the discrepancy has been corrected and/or retainage of sufficient monies to prepare same.

D. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner's operating and maintenance personnel in the proper operation and maintenance of the systems. Instruction period shall be a minimum of five (5) eight-hour

days. Coordinate with Commissioning Agent per specification section 01 91 00.

E. Refer to SECTION 01 75 00, Starting and Adjusting. Coordinate all start-up, operation, and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification section 019100.

1.18 RECORD DRAWINGS

A. General: Refer to Division 1, General Requirements, SECTION 017800, Close-out Submittals for Requirements.

B. The record drawings required to be furnished under this SECTION are of drawings numbered M0.1 through M7.5.

1.19 CONTRACT COST BREAKDOWN

A. Within 30 days of commencing the work, submit to the Architect a complete breakdown of the Contract price to aid in determining the value of the installed work during the construction period. The form shall correspond to the construction schedule with a percentage of progress to complete breakdown with progress description by month.

1.20 GUARANTEE AND SERVICE

A. Attention is directed to the provisions of the CONTRACT AND GENERAL CONDITIONS regarding guarantees/warranties for the Work.

B. Manufacturers shall provide their standard guarantees/warranties for work under this Section. However, such guarantees/warranties shall be in addition to and not in lieu of all other liabilities which the manufacturer and the Contractor may have by law or by other provisions of the Contract Documents.

1.21 DEBRIS REMOVAL AND CLEAN-UP

A. The HVAC Subcontractor shall, at the end of each day's work, remove waste materials and debris resulting from the installation of the heating, ventilating and air conditioning system. The HVAC Subcontractor shall deposit such waste and debris in a dumpster on-site. Dumpster shall be provided by the General Contractor. The General Contractor shall be responsible for the emptying of dumpster when required.

The HVAC Subcontractor shall, at the completion of his work, remove from the school property all tools, equipment and surplus materials resulting from the installation of the heating, ventilating and air conditioning system.

1.22 COMMISSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. This contractor shall assist and support the CA as necessary in accordance with the requirements of specification section 019100 – COMMISSIONING.

1.“Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Tenant’s and Building Owner’s operation and maintenance personnel, is required in cooperation with Tenant’s and Building Owner’s Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Specification, Section 019100, for detailed commissioning requirements.”

1.23 EXAMINATION OF SITE AND DOCUMENTS

A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from General Contractor or Filed Subcontractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Pre-Bid Conference: Bidders are strongly encouraged to attend the Pre-Bid conference; refer to INVITATION TO BID for time and date.

1.24 SEQUENCING

A. Phasing: Refer to Section 01 10 00 - SUMMARY, and Drawings for phasing and milestone completion requirements which affect the General Contractor’s Work and the Work of this Filed Subcontract.

B. Coordinate work of this Filed Subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.

C. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this Filed Subcontract, have been received and approved by the Architect.

D. Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

PART 2 PRODUCTS

2.1 ACCESS PANELS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels for installation in walls and ceilings at locations indicated on the drawings to permit access.

C. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that junction can be easily reached and the size shall be sufficient for this purpose (minimum 12 inches x 16 inches). When the access panels are required in corridor, lobbies or other habitable areas, they shall be located as directed by the Architect.

D. Access panels shall be as manufactured by Inland Steel Products Company "Milcor", Walsh-Hannon-Gladwin, Inc., "Way-Loctor" or approved equal. Types shall be as follows:
   1. Masonry or Tile "Milcor" Type M
   2. Drywall "Milcor" Type DW
   3. Fire-Rate "Milcor"

E. Units shall have 16 gauge steel frame and 14 gauge steel hinged door panel. Door shall have concealed spring hinges allowing door to be opened to 175 degrees.

F. Provide flush screwdriver operated camlocks in accordance with manufacturer's schedule of panel sizes and number of locks.

G. Units shall be factory primed for field painting by Section 09 00 09.

H. Install U.L. rated 1-1/2 hour Class B access panels where required to comply with applicable code requirements.

2.2 AIR SEPARATORS

A. Furnish and install as shown on the drawings a Spirotherm, Bell & Gossett, or Taco air separator on the hot water heating system and chilled water system.

B. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and velocity not to exceed 4 feet per second through the unit at specified GPM. Performance curves specifying air collection efficiency and pressure drop at rated flow shall be furnished by the unit manufacturer as part of the submittal for each unit.

C. All units shall include an integral spirally wound three dimensional copper grid to act as a turbulence suppressive coalescing medium which must completely fill the fitting's internal area. Units are to remove free and entrained air during system start up and continue to eliminate dissolved air through continual circulation and the coalescing action of the spirally wound grid.
   1. Alternate units shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

D. Each fitting is to have a separate air and venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated brass air vent. There shall be no restriction in the connection from the venting chamber to the vent.

E. The fittings are to include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Units shall include a bottom connection for use as a blow down connection for periodic cleaning.

F. Provide integral high capacity float actuated air vent at top fitting of tank.
   1. Alternates must include bronze or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the fitting.
   2. Unit shall have bottom blow down connection.

2.3 BOILERS

A. Furnish and install in accordance with plans and specifications, including manufacturer's recommendations, state and local code, hot water boilers. The hot water boilers shall be as manufactured by Cleaver-Brooks, Aerco, Buderus, or Viessmann, rated at 60 psig design pressure and capacity, as scheduled on the drawings and specifications.

B. Boiler Design
   1. Boiler shall be a compact Firetube type, single pass, and down-fired design with ultra-low emission and high efficiency condensing technology herein listed. The boiler shall be designed for natural gas firing. The burner shall be a forced draft design with gas and combustion air premixed prior to the burner head. The boiler, and burner, shall be supplied by the same manufacturer to assure compatibility and single source responsibility for the package performance. The boilers shall be constructed in accordance with ASME Section IV Code. Boiler to be manufactured within an ISO 9001 certified facility.
   2. The boiler shall be constructed with a minimum of ten (10) square feet of fireside heating surface per 33,475 BTU's of input.
   3. The pressure vessel shall be constructed with stainless steel boiler tubes with titanium stabilized aluminum extended internal heating surface (AluFer). Firetube internal surface shall be a minimum of four (4) times the external waterside surface area. The pressure vessel shall be of a "counter flow" design with separated return flow connections and no minimum system flow requirements.
   4. Other
      a. Two-inch (2") fiberglass blanket insulation and easily removable casing.
      b. Burner observation port.
      c. Factory paint with durable powder coat paint finish for corrosion protection.
      d. ASME Code relief valves with side outlet set for 60 psig.
   5. Hot water boilers shall be specifically designed for top water outlet and bottom water inlet with necessary internal baffling.

C. Computerized Burner Control
   1. Boiler burner controls shall be an integrated, digital modulating controller.
   2. Controller shall provide the following functions:
      a. Two (2) heating loops
      b. Burner sequencing with safe start check, pre-purge, direct spark ignition and post purge.
      c. Electronic ignition.
      d. Flame supervision.
      e. Safety shutdown with display of error.
      f. Modulating combustion fan.
      g. Circulating pump operation.
      h. Low gas pressure, air proving, high limit and frost protection.
   3. Controller shall have an option for multiple boiler sequencing.
   4. Controller shall have an option for communication device to computer interface. Boiler manufacturer shall coordinate with Invensys/ENE for compatibility requirements.

D. Burner Design
   1. Burner shall be a unitized Venturi, gas valve, blower and burner head design.
   2. Burner shall incorporate a variable speed DC combustion air fan capable of modulating the burner at a 5:1 ratio from high fire to low fire.
   3. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame.
   4. Burner shall produce less than 70-dBA sound reading at full firing rate.

E. Electrical Requirements
   1. Power available with be 220-1-60 phase with option for 115-1-60.
   2. All wiring shall be in compliance with National Electrical Code.

F. Efficiency
   1. The boilers will have a guaranteed efficiency of up to 98% based on return water temperatures of 80ºF at full firing rate.

G. Emissions
   1. Burner boiler design shall produce NOx emission levels of less than 10 PPM at full firing rate.

H. Operating Tests, Startup and On Site Services
   1. A single vendor to assure proper installation and service design interface, and to provide in-warranty and post-warranty unified responsibility for the Owner and Consulting Engineer, as well as shall furnish the boiler system and accessories.
   2. Boiler vendor's service organization shall employ service technicians having experience in all aspects of troubleshooting, corrective service, and preventative maintenance O&M reporting. Service personnel shall be full-time employees of the Vendor's organization and shall be available twenty-four (24) hours per day and three hundred, sixty-five (365) days per year.
   3. Boiler vendor shall be covered by a general liability insurance policy. Boiler vendor shall provide the Owner with a Certificate of Insurance specifying amounts and types of coverage. All personnel involved in start-up service, adjustment, or testing of equipment must be covered under this insurance.
   4. Boiler vendor shall provide a factory trained service engineer for periodic supervision during installation, field start-up service to supervise starting, adjusting and testing of boiler, training of the operating personnel in the proper operations and maintenance. Duration of training shall be of sufficient time to insure competent operation of boilers by owner’s maintenance personnel. Boiler start-up and training shall be coordinated with the Commissioning Agent; refer to specification section 019100.

I. Manufacturer's Warranty
   1. All equipment shall be guaranteed against defects in materials and/or workmanship for a period of twelve (12) months from the date of startup, or eighteen (18) months from the date of shipment, whichever comes first. The warranty shall include parts only to repair or replace all defective parts and materials.
   2. The pressure vessel shall be warranted for twenty (20) years against thermal shock.

J. Condensate Neutralization Kit
   1. Boiler manufacturer shall provide a neutralization kit which shall consist of the following:
      a. Replaceable acid neutralization filter cartridge designed for six (6)

months of use. The filter housing outlet shall be piped to drain.

b. Condensate removal pump. The condensate pump shall be capable of handling 70 GPM at 5 ft/hd. The pump discharge shall be piped to filter inlet.

K. Boiler Sequencing and Control System

1. When multiple condensing boilers are to be installed in a common hydronic loop, a sequencing control system shall be provided by the boiler manufacturer to stage and control firing rate of the boilers. To ensure proper integration with the Cleaver-Brooks Clearfire boiler controls, the boiler manufacturer shall supply a boiler sequencing control system. The boilers shall be sequenced as follows to maximize their operating efficiency:
   a. The sequencing control system shall monitor the outdoor temperature and calculate a water loop temperature set point based on the selectable preset values. The sequencing system shall begin sequencing the condensing boilers based on the difference between the actual water loop temperature and the calculated (outdoor air) water temperature.
   b. When a requirement for heat is determined by the boiler sequencing control system, the lead boiler is energized and its firing rate is maintained at low fire.
   c. If the water loop temperature continues to decrease, the boiler sequencing control system shall enable a lag boiler. The first lag boiler is energized and the lag boiler's firing rate is maintained at low fire.
   d. If additional heat is required, the boiler sequencing control system shall enable each additional lag boiler stage until all of the available condensing boilers in the water loop have been energized. Each boiler stage shall remain at low fire until all of the stages have been enabled.
   e. If all of the condensing boilers are enabled and additional heat is required, the boiler sequencing control system shall release the boilers to modulate. The condensing boilers shall modulate together as a single unit to keep the condensing boiler system at the lowest possible firing rate.
   f. As the water loop temperature increases, the boiler sequencing control system shall decrease the firing rate of the condensing boilers to maintain the water loop temperature. If all of the condensing boilers are at low fire and the water loop temperature continues to rise, the boiler sequencing control panel shall begin to stage the boilers off. The first lag boiler energized shall be the first boiler to be disabled. The condensing boilers shall continue to be disabled by the boiler sequencing control system based on the temperature rise of the water loop.
   g. The lead boiler is disabled when the water loop temperature reaches a selectable value referenced around the water loop set point.
2. The boiler sequencing control system shall be a microprocessor based Programmable Logic Controller with a Graphical User Interface and Touch Screen capabilities. Active display area will be a minimum of 4.7" with a display resolution of 320 x 240 pixels. Multiple Status and Configuration Screens will be available for easy interpretation of the hydronic loop status and configuration. The boiler sequencing control system enclosure will be NEMA 4X construction. Power required for the boiler sequencing control system will be 120/60/1.
3. The boiler sequencing control system shall have the ability to communicate with the Building Management System via BACnet MS/TP RS-485 or BACnet IP via ethernet. The boiler control system manufacturer shall furnish an interface gateway if required.
4. The boiler sequencing control system Sequencing Control shall include

automatic rotation of the lead boiler based on a user configured cycle count. Manual selection of the Lead boiler will also be available through a Setup Menu.

5. Outdoor and loop header temperature sensors supplied with the boiler sequencing control system shall be PT100 RTD type.
6. The boiler sequencing control system sequencing control shall provide an adjustable reset schedule based on the outdoor temperature. A linear outdoor reset ratio shall be determined based on user defined hydronic loop temperatures at 60ºF and 0ºF outdoor temperatures. A reference graphic shall be displayed on the Boiler sequencing control system representing the reset loop temperature vs. outdoor temperature calculated ratio. A user defined outdoor temp disable parameter shall be provided to turn off all boilers if a predetermined outdoor temperature is reached. Minimum and Maximum Loop Temperature parameters shall be provided for both Occupied and Unoccupied modes. This shall prevent the outdoor reset schedule from operating outside of a user defined temperature range.
7. Provisions shall be provided that monitor the boiler's outlet temperature and adjusts the firing rate if the boiler's outlet temperature exceeds a user defined value above the loop set point. This is beneficial for variable flow loops to prevent high temperature limit alarms.
8. Multiple setback schedules shall be available based on whether the building is in Occupied or Unoccupied mode. Building Mode selection shall be determined by a user defined Time of Day / Day of Week Touchscreen entry. The Building Mode shall automatically change between Occupied and Unoccupied based on the user programmed day and times. Manual Building Mode control shall also be available via a Setup menu. Building Mode shall be indicated on the Loop Status Screen for ease of reference.
9. The boiler sequencing control system Sequencing Control shall provide alarm annunciation of each boiler connected to the network. The boiler sequencing control system shall automatically adjust the boiler sequencing schedule and remove the boiler from the sequencing logic if an alarm occurs. The boiler shall automatically be added back into the rotation loop as soon as the boiler sequencing control system senses that the alarm has been cleared.
10. The boiler sequencing control system will stage the boilers based on a PID generated value. The Proportional, Integral and Derivative values shall be user defined through the Lead/Lag Configuration Screen. Each boiler stage shall be enabled based on a user defined "Percentage from Set point" control variable. Properly tuned loops shall provide temperature control accuracy up to +/- 2ºF. Boiler Sequencing Start and Stop parameters shall be user defined through the operator interface. A Manual Reset parameter shall be provided to allow the Proportional Band to be shifted around set point.
11. The boiler sequencing control system shall provide capabilities to Enable/Disable the boilers through the operator interface. Boilers that are disabled shall not be included in the sequencing logic.
12. A user defined time delay parameter shall be provided that delays enabling of the next boiler stage. This shall help to decrease cycling of the boilers when the heat load is close to being met.
13. The boiler sequencing control system shall modulate the individual boiler's automatic two-way control valve isolate any boiler not online. The boiler sequencing control system shall provide a user defined time delay to keep the isolation valve open to relieve heat from the boiler after being staged off.

2.4 BREECHING AND CHIMNEY (DOUBLE WALL AL29-4C)

A. Furnish and install, where indicated on plans, non-positive and positive pressure vent systems for condensing and non-condensing applications.

B. Standards:
   1. Where applicable, products furnished under this section shall conform to the requirements of NFPA 54 and NFPA 211, and shall comply with UL 1738, Standard for Venting Systems for Category II, III, and IV Gas-Burning Appliances, and all other applicable standards.
   2. All flue-gas carrying components of the vent system shall be obtained through one source.
   3. Vent shall be warranted by the manufacturer against defects in material and workmanship for a period of one (1) year from the date of original installation. Any portion of the vent repaired or replaced under warranty shall be warranted for the remainder of the original warranty period.

C. Special Gas Vent:
   1. Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category I, II, III, and IV appliances, or as specified by the equipment manufacturer.
   2. Maximum continuous flue gas temperature not to exceed 550 degrees Fahrenheit (288 degrees Celsius).
   3. Vent shall be constructed with an inner conduit constructed of AL29-4C® or 29-4 (S44735) superferritic stainless steel with a minimum thickness of .015" for diameters 3"-8", .020" for diameters 10"-16", .025" for diameters 18"-24", and .035" for 26" and greater.
   4. Vent shall be listed for an internal static pressure of 15" w.g. and tested to 37" w.g.
   5. All inner wall conduit components shall be manufactured from AL29-4C® or 29-4 (S44735). The closure system shall be a mechanical locking strap closure system that is integral to the system.
   6. Joints to be sealed with factory supplied sealant. Joints shall be designed to minimize collection of condensate in both horizontal and vertical runs. Joints shall not use screws or other lesser alloy fasteners that penetrate the inner conduit.
   7. The outer wall casing shall be constructed of 430 stainless steel that shall not require additional surface preparation, such as painting, in order to withstand the outdoors or high humidity environments.
   8. Inner conduit and outer wall casing shall be constructed with a one-inch air space between them and in such a fashion that prevents cross-alloy contamination.
   9. Tees and elbows shall provide a pressure drop less than 15 feet equivalent horizontal vent.
   10. Fittings that increase or decrease vent diameter shall be asymmetric in construction with a flat wall that maintains a straight line with adjoining parts in order to facilitate the unobstructed flow of all condensate.
   11. All parts shall be compatible with other single wall and double wall products of the same manufacturer.
   12. System is to be sized in accordance with the appliance manufacturer's specifications, NFPA 54-National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and other applicable codes.
   13. System shall be design with parts that will allow for clearance to combustibles of 1" for diameters 6"-24" unenclosed in the horizontal and enclosed in the vertical; and for clearance to combustible of 2" for diameters 26"-32" unenclosed in the horizontal and enclosed in the vertical.

14. Manufacturer shall provide, if needed, any custom made part to aid in a quick and effective installation. Custom parts will meet all criteria 3.1.A through 3.1.N.

D. Sealant:
1. General Electric RTV106 High Temperature Sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550°F.
2. In lieu of high temperature sealant, a factory installed 550°F compatible gasket shall be used to seal the joints.

E. Illustrated installation manuals shall be supplied to the installer and shall be available for downloading from the manufacturer's website.

F. All components shall be installed in strict compliance with the manufacturer's instructions and all pertinent local, regional, national, and international building and mechanical codes and regulations.

G. Vent shall be Saf-T Vent® CI Plus as manufactured by Heat-fab, Inc. or approved equal."

2.5 CABINET UNIT HEATERS

A. Cabinet unit heaters shall be of the size, type and capacity indicated on drawings. Equipment shall be as manufactured by Vulcan, Sterling, Rosemex or Rittling.

B. Cabinet unit heaters shall consist of a heating element with centrifugal fans driven by an electrical motor, filter, and where semi or fully recessed, they shall be flanged on four sides. They shall be capable of delivering the indicated heat emission with entering air at 60 degrees F. Each unit shall be provided with manual on-off switch and two-speed selector switch.

C. All cabinet parts shall be factory finished. Color to be determined by Architect.

2.6 CHEMICAL TREATMENT

A. Provide where shown on drawings and as specified herein the equipment necessary for chemical treatment and service as provided by New England Systems and Supply, Inc., Nutmeg, Metropolitan Refinery Company, Inc., Barclay Chemical Company, Inc., Betz Company or Water Services Laboratories, Inc., or approved equal.

B. The contract agreement satisfactory in form and substance to the Owner – executed between this Contractor and the chemical treatment company to furnish supervisory service to assure the use of proper chemical treatment to and for systems, installed under this contract, hot water, chilled water and condenser water, for a period of one (1) year from date of initial treatment thereof. The Contract: Assigned by this Contractor to the Owner on the date that the building is accepted by the Owner, so that chemical treatment will continue uninterrupted during the one year life of the contract. If the building is not accepted by the Owner prior to the expiration of the one year contract, arrangements shall be made by this Contractor to extend this contract until the building is accepted by the Owner.

C. Chemical treatment company shall perform the following through its agents:
1. Supervise initial cleaning of systems and equipment.
2. Supervise initial introduction of chemical treatment.
3. Furnish service calls by its agents at a frequency of not less than one (1) per thirty (30) days thereafter, during the one (1) year life of the contract.
4. Furnish all required chemicals for proper treatment of all systems hereinafter

described, together with all necessary testing equipment and reagents for field analysis of the water during the aforementioned one year contract.

5. The chemical treatment company shall assume responsibility for field testing and control and regular addition of chemical treatment in whatever amounts are necessary on each of the systems hereinafter described, as provided by the chemical treatment company until the date of acceptance of the building by the Owner.
6. Some water circulating pumps shall have mechanical seals as specified in this section. It shall be the responsibility of the chemical treatment company to coordinate with the pump manufacturer and adjust the formulation of the water treatment chemicals to be assured that the normal life of the mechanical seals is not affected.
7. The chemical treatment supplier shall provide chemicals which are non-pollutants and meet Federal Water Quality criteria.
8. The chemical treatment company shall establish, document and submit to the Architect volumes of each system or sub-system for which treatment is provided.
9. The chemical treatment company shall provide start-up and training support to the owner. Training shall be coordinated with the Commissioning Agent. Refer to specification section 019100 for additional requirements.

D. Hot Water Systems: Provide for each system one liquid chemical bypass type feeder of approximately 5 gallon capacity, complete with valves and fittings which shall be connected across each hot water heating system pump set.

E. Chilled Water System: Provide liquid chemical bypass type feeder of approximately 5 gallon capacity, complete with valves and fittings connected across the chilled water pump sets.

F. Chemical cleaning solutions used shall not be harmful to materials of construction. After systems have been drained, flushed and refilled, a chemical test shall be made by the chemical treatment company to determine that cleaning solution remaining in system does not impart alkalinity to water in excess of 300 ppm. A written report to this affect shall be submitted to the Architect.

G. Initial Cleaning of Chilled Water, Hot Water Piping System: Cutting oil, excess pipe joint compound, finely divided solids and other similar foreign materials shall be removed from all circulating water and steam piping systems before they are placed in operation. The cleaning materials used shall be supplied and applied by the chemical treatment company and all circulation, draining, flushing and refilling work shall be done by this Contractor, as directed by the chemical treatment company.

H. Refer to Piping Systems Flushing and Cleaning for additional requirements.

2.7 CHILLER (AIR COOLED)

A. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. The contractor shall furnish and install air-cooled rotary liquid chiller of size and capacity scheduled. Unit shall be installed in strict accordance with this specification. All units shall be furnished complete with helical rotary compressors, shell and tube evaporator, air-cooled condenser, electronic expansion valves and microprocessor control panel. Total unit shall be UL certified and include the UL label. The unit shall be designed for outdoor application. The unit shall be rated in accordance with AHRI Standard 550/590-2003.

C. Air cooled water chiller(s) shall be manufactured by Trane, York, Carrier or McQuay.

D. Compressors
1. Construct chiller using semi-hermetic helical rotary screw compressors with independent circuits.
2. Statically and dynamically balance rotating parts.
3. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
4. Provide compressor with automatic capacity reduction equipment consisting of capacity control slide valve. Compressor must start unloaded for soft start on motors.
5. Provide constant speed 3600 rpm for 60Hz (or 3000 rpm for 50Hz) compressor motor, suction gas cooled with robust construction and system design protection, designed for across-the-line or wye-delta starting. Furnish with starter.
6. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.
7. Provide sound absorbing panels to attenuate compressor noise.

E. Evaporator
1. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.
2. Insulate the evaporator and water boxes with a minimum of 3/4 inch (K=0.26) insulation. If field installed the additional money to cover this in the field should be included in the bid.
3. Evaporator heat tape shall be factory installed and shall protect unit down to -20 F. Contractor shall wire separate power to energize heat tape and protect cooler while chiller is disconnected from the main power.
4. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
5. Provide ability to remove evaporator tubes from either end of the heat exchanger.
6. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
7. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2 separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.
8. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

F. Condensers and Fans
1. Provide vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be either PVC, chrome, or zinc coated.
2. Provide TEAO (Totally Enclosed Air Over) fan motors with permanently lubricated ball bearings.
3. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 506 psig.
4. Provide coil protection for shipping. Entire condenser coil shall be covered with heavy plastic to prevent inadvertent damage to coil during shipment or rigging.

G. Enclosures/Starters
1. House components in a galvanized steel frame and mounted on welded

structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

2. Unit panels and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.
3. Mount starters and Terminal Blocks in weatherproof panel provided with full opening access doors. Factory mounted and wired disconnect should be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off.
4. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.
5. For each compressor provide a wye-delta starter. Delta-Delta and Solid State Starters shall be unacceptable because they accomplish a smaller reduction in inrush than Y-delta.

H. Refrigerant Circuit
1. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressors on each circuit. Single refrigerant circuit chillers are not acceptable.
2. Provide for each refrigerant circuit:
   a. Liquid line shutoff valve.
   b. Suction Service Valve
   c. Filter (replaceable core type).
   d. Liquid line sight glass.
   e. Electronic or thermal expansion valve sized for maximum operating pressure.
   f. Charging valve.
   g. Discharge and oil line check valves.
   h. High side pressure relief valve.
   i. Full operating charge of HFC-134a and oil for packaged units only. Units with remote evaporator option selected will ship with an oil charge and a nitrogen holding charge.
3. Capacity Modulation: Provide capacity modulation that includes linear unloading to maintain close leaving water temperature control. Unit shall be capable of operation down to 20%.

I. Controls
1. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
   a. Phase reversal/unbalance/single phasing and over/under voltage protection.

b. Low chilled water temperature protection.
c. High and low refrigerant pressure protection.
d. Load limit thermostat to limit compressor loading on high return water temperature.
e. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize unit efficiency.
f. Display diagnostics.
g. Oil pressure control based off of maintaining system differential pressure.
h. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.

2. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.
   a. The unit controller shall utilize a microprocessor that will automatically take action to prevent unit shut down due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.
3. In the above case, the chiller will continue to run in an unloaded state, and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset will be required. Once the "near-trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
4. Provide the following safety controls with indicating lights or diagnostic readouts.
   a. Low chilled water temperature protection.
   b. High refrigerant pressure.
   c. Low oil flow protection.
   d. Loss of chilled water flow.
   e. Contact for remote emergency shutdown.
   f. Motor current overload.
   g. Phase reversal/unbalance/single phasing.
   h. Over/under voltage.
   i. Failure of water temperature sensor used by controller.
   j. Compressor status (on or off).
5. Provide the following operating controls:
   a. Eight (8) or more step leaving chilled water temperature controller which cycles compressors and activates cylinder unloaders or slide valve based on PI algorithms. If manufacturer is unable to provide at least 8 steps of unloading, providing hot gas bypass shall be required.
   b. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
   c. Chilled water pump output relay that closes when the chiller is given a signal to start.
   d. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
   e. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure

nuisance trip outs on days when outside ambient is above design.

f. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.

g. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.

h. Low ambient lockout control with adjustable set point.

i. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

6. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
   a. Leaving chilled water set point adjustment from LCD input
   b. Entering and leaving chilled water temperature output
   c. Percent RLA output for each compressor
   d. Pressure output of condenser for circuits one and two
   e. Pressure output of evaporator for circuits one and two
   f. Ambient temperature output
   g. Voltage output
   h. Current limit set point adjustment from LCD input.
   i. Remote leaving water temperature set point.
   j. Alarm indicating light and relay.
7. Provide factory installed contact closure input for initiation of ice building. Ice building termination shall be based on an adjustable entering water temperature set point. All compressors shall run at full load during ice building.
8. The chiller control system shall be capable of communicating with the building management system via BACnet MS/TP RS-485 or BACnet IP via ethernet.
9. Any and all communication interface cards required shall be furnished by the chiller manufacturer.
10. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
11. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
12. The chiller control panel shall provide input for leaving chilled water temperature set point based upon a 2-10VDC or 4-20mA signal from a building automation system.
13. The chiller control panel shall provide input for chiller current limit set point based upon a 2-10VDC or 4-20mA signal from a building automation system.

J. Regulatory Requirements
1. Conform to ANSI/AHRI 550/590-2003 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.
2. Conform to ANSI/UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
3. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.
4. Conform to ANSI/ASHRAE 15 code for construction and operation of water

chillers.

5. Chiller must be built in an ISO 9001 classified facility.

K. Verification of Capacity and Efficiency

1. The chiller (one of each size) shall be factory performance tested under full load conditions in an ambient controlled, AHRI 550/590-2003 approved test facility. The manufacturer shall supply a certified test report to confirm performance as specified. The performance test shall be conducted in accordance with AHRI Standard 550/590-2003 procedures and tolerances.
   a. The performance test shall be run with clean tubes in accordance with AHRI 550/590-2003 to include the following:
   b. Downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
   c. The factory test instrumentation shall be per AHRI 550/590-2003, and the calibration of all instrumentation shall be traceable to the National Institute of Technology.
   d. The owner or his representative shall be notified 14 days in advance to witness the factory performance test. If the owner or his representative desires to witness the performance test, all travel expenses will be the owner's responsibility.
   e. A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

L. Manufacturer's Field Services

1. OEM Startup shall be performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
2. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

M. Warranty

1. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.
2. A 5-year motor/transmission/compressor warranty shall be provided.

2.8 CONVECTORS

A. Furnish and install where shown on the drawings, convectors with inlet grilles and access doors of sizes, capacities and type indicated on the schedule. All convectors shall be complete with air vent chamber and key operated air cocks. Heating elements shall consist of seamless copper tubes, non-ferrous fins, cast iron headers and galvanized steel sideplates and tube supports. Each convector shall have installed in return line an approved balancing fitting with adjusting screw. All recessed convector casings on outside walls shall be entirely covered within recess with at least 1/2 inch insulation sheet securely secured to the casing. All exposed screw heads shall be tamperproof, Phillips, Allen or approved equal. All recessed and semi-recessed convector front panels shall be 14 gauge enameled steel and be flanged on four sides. The convectors shall be as manufactured by Vulcan, Sterling, Rosemex or Rittling.

B. Convectors shall be factory finished. Color to be determined by Architect.

2.9 DUCTLESS SPLIT FANCOIL SYSTEM

A. Provide a complete split system type ductless fancoil air conditioning system consisting of compact mounted packaged evaporator sections with matching air cooled outdoor condensing unit. The units shall be listed by the Electrical Testing Laboratories (ETL) and bear the ETL label. All wiring to be in accordance with the National Electrical Code (NEC). The units shall be rated in accordance with ARI Standard 210 and bear the ARI label. A full charge of R-410a for 25 feet of refrigerant tubing shall be provided in the condensing unit. System SEER shall meet or exceed 1992 Federal Standards.

1. The system components shall be provided by a single manufacturer to provide for an integrated, 100% compatible installation. System shall be as manufactured by Mitsubishi Company, Sanyo Company or Trane.

B. The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the site of installation.

C. The indoor unit shall provide a total minimum cooling capacity as scheduled on the drawings. The units shall have a SEER rating as indicated on the equipment schedule at ARI Standard conditions. The system net minimum total cooling capacity shall be rated at 67 degrees FDB indoor and 95 degrees FDB air entering the outdoor coil.

D. The indoor unit shall be completely factory assembled and wired. The casing shall be of galvanized sheet steel, phosphatized, bonderized and finished in a baked enamel white finish.

1. The evaporator fan shall be a high performance forward curve line flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and shall run on permanently lubricated bearings.
2. An adjustable change vane shall be provided with the ability to direct the air flow from horizontal to vertical. An adjustable guide vane shall be provided to manually change the air direction from left to right.
3. The evaporator coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested to 450 psig at the factory.
4. An insulated condensate pan with drain shall be provided under the coil.

E. The control system shall consist of multiple microprocessor sections. One microprocessor shall be factory wired and located within each indoor unit. It shall have the capability of sensing room temperature and indoor coil temperature; receive and process commands from the remote controller; and control the outdoor unit. The Contractor shall be responsible for required interlock wiring.

1. The microprocessor within the wall mounted remote controller shall display setpoint; provide two (2) manually selected modes of cooling, normal and economy operation at 2 degrees above setpoint; night set back operation of 4 degrees above setpoint; and manual or automatic fan speed control.
2. The optimum temperature shall be memorized for immediate recall as the system default setpoint whenever the system is used again.
3. The system shall be capable of automatic restart when power is restored after power interruption.
4. Automatic fan speed control shall be based upon the temperature difference between setpoint and room temperature maintaining lowest speed possible.
5. A remote control unit shall be wireless, using infrared, line of sight for control of system and shall include automatic ON/OFF timer; liquid crystal display, and temperature reset capability. Furnish and install, in the field, on the wall, a

remote control unit holder.

F. The outdoor unit shall be completely factory assembled, piped and wired. The casing shall be fabricated of galvanized steel, phosphatized, bonderized and finished with baked enamel. The unit shall be furnished with direct drive, propeller type fans arranged for horizontal discharge.
   1. The motor shall have inherent protection, be of the permanently lubricated type and resiliently mounted for quiet operation.
   2. The fans shall be provided with a raised guard to prevent contact with moving parts.
   3. Multiple compressors shall be provided, one for each indoor evaporator fancoil unit. The compressors shall be of the high performance rotary type with accumulator and internal thermal overloads. The compressors shall be mounted so as to avoid the transmission of vibration.
   4. The refrigeration system shall have the capability to operate with maximum height difference of 25 feet and overall refrigerant tubing length of 160 linear feet between indoor and outdoor sections without the need for line size changes, traps, or additional oil. Refrigerant flow from the condenser to be controlled by means of capillary tubes.
   5. The condenser coil shall be non-ferrous construction with smooth plate fins bonded to copper tubing. The coil shall be protected with an internal metal guard finish to match unit panels.
   6. The unit shall be controlled by the microprocessor located in the matching indoor units.

2.10 ENERGY RECOVERY UNIT (ERU-1 through ERU-8)

A. Manufacturers: Units shall be as manufactured by Annexair, Hakkon, Seasons Four, or approved equal.

B. General:
   1. Unit shall be factory fabricated. Unit manufacturer shall be responsible for provisions of fans, dampers, coils and all other unit and plenum components as specified in this section or other sections of this division and performance characteristics as shown in schedules or on drawings. Contractor designed or assembled air handling units shall not be acceptable or considered as equal.
   2. Unit shall be factory-fabricated for shipping and field assembly by experienced manufacturer of large custom air handling units that maintains engineering and production staff.
      a. Provide proof of credentials of manufacturer's staff.
   3. Shop drawings shall be subject to approval of the Owner and Architect.
   4. Certify conformance with performance requirements specified and shown on Drawings.
   5. Provide necessary appurtenances to perform as specified, whether or not expressly required by Contract Documents mentioned herein in conformance with good trade practice, as determined by Architect.
   6. The factory modular units shall be constructed on a roof curb or steel dunnage provided under other sections. Mechanical Division Contractor shall carefully coordinate dimensions of air handling unit with framework or curb dimensions.
   7. Unit manufacturer shall seal any casing penetrations made in field for piping, conduit, tubing and equipment installed under other sections. Advise manufacturer in advance of required field penetrations of casing.

C. Testing:
   1. Test to ensure structural integrity, design suitability under simulated operating

conditions, systems operation and minimum vibration levels as specified. Certify that unit complies with design intent and Contract Documents.

2. Manufacturer shall be responsible for correcting any operating deficiencies found during the unit startup after installation.
3. Prior to shipping the following tests shall be performed:
   a. Pressure test water coils if coil manufacturer has not already performed pressure test, and piping.

   b. Unit operation and vibration analysis. Operate fans at design RPM, set fan drive and conduct complete vibration spectrum as specified. Fan, motor, drive and base assembly, vibration shall be brought to within specified levels. Check motor and drive vibration with fan as a completed assembly.
   c. Energize electrical devices to ensure operational integrity prior to shipment. Replace non-functioning items.
   d. Submit housing panel acoustical, structural and physical properties performance test data before shipment from independent recognized test laboratory.

D. Unit shall comprise of, but not limited to, AHU sections shown on drawings and the following list:
   1. Double wall cabinet.
   2. Hot water heating coil section
   3. Chilled water cooling coil section
   4. Pre Filter section
   5. Supply air fan section.
   6. Intake section with dampers.
   7. Fan motors compatible with variable frequency drives
   8. Variable frequency drives for fan motors, condenser fans and compressors.
   9. Outside air intake plenum
   10 Exhaust air fan section.
   11. Rotary enthalpy energy recovery wheel section
   12. Return section with dampers.

E. Costs associated with dimensional, performance or other deviations from the specified equipment, including engineering costs to evaluate such deviations, shall be paid by the contractor.

F. The unit(s) shall be installed in strict accordance with the specifications. Unit(s) shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995 / CAN/CSA C22.2 No.236. Units shall be rated and ETL listed for electric heaters with single point power connection for the entire unit, up to 100kW.

G. Quality Assurance:
   1. All unit(s) shall be factory run tested before shipping. A proof copy of the test shall be placed in the unit electrical power & control panel. Unit(s) shall bear the ETL label, tested in accordance to UL 1995. Electrical components shall be UL listed; fans shall be tested in an AMCA certified laboratory; insulation shall comply with NFPA 90A; coils shall tested in accordance to ARI 410 and filters shall be tested in accordance to ASHRAE 52. The unit manufacturer shall have an independent testing agency test the air leakage, panel deflection and sound

pressure levels for a typical unit providing at minimum the supply airflow of units in question and not exceeding 20,000 CFM. The air leakage of the unit(s) shall not exceed 1% at 10" inches H2O positive static pressure and a copy of the report must be submitted upon request. Unit shall be constructed to limit frame and panel deflection to 1/250th of the panel length at 10" inches H2O positive static pressure and a copy of the report must be submitted upon request. The unit shall also be tested in accordance with ANSI S12.34-1998 and instrumentation used must be in compliance with the requirements of AMCA 300 for sound readings. The sound tests conducted shall report overall sound power and pressure readings for supply air outlet, return air inlet and casing radiated.

H. Housing:

1. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one piece as shown on drawings. The frame shall consist of robust injection molded corners and extruded thermally broken aluminum profiles; welded together for reinforcement. Base structure shall be fully welded with formed heavy gauge galvanized steel and have integral lifting lugs which can be removed once the unit is installed. "Thermo-composite" panels shall be mechanically fastened to the base structure. Unit casing must be guaranteed to have no exterior condensation at interior AHU temperatures down to 43F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb.
2. All roof, floor and wall panels shall be made from "thermo-composite" panels, with an aluminum interior and exterior liner. All panels and access doors shall be 2" thick double wall construction with R14 foam insulation, and Greenguard certified®. The panels shall be capable of withstanding air pressure up to 10" w.c with 1/16" panel deflection. Panels shall be fastened from the interior and gasketed along the frame to reduce thermal transmission. Fixed panels shall be removable without affecting the housing integrity.
   a. Alternate construction: All roof and wall panels shall be made from aluminum, minimum. 12 Ga Aluminum Exterior wall and 22 Ga Steel Metal Liner. All panels and access doors shall be double wall construction with (R-12) two-inch thick, minimum 3.0 pcf polyisocyanurate foam insulation. All casing panels and frame must be provided with true thermal break. Base shall be fully welded with formed heavy-gauge galvanized steel with removable integral lifting lugs. .125" Aluminum Checkerplate Floor – Fully Welded, capable of holding 1.5" of water. 6" channel base rail. Floor shall be aluminum, minimum .063", mechanically fastened to the base with minimum (R-12) two-inch thick polyisocyanurate foam insulation and 22ga Galvanized Steel metal under liner.

1. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than L/1150 at 10'' and withstand air pressures up to 8" w.c. Leakage to be guaranteed at no more than 1% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater. All casing walls shall be of panel construction, including the fan discharge walls, mixing section walls.
2. Access doors shall be provided to all major components to facilitate quick and easy access. Access doors are to be provided with open guard door locks to lock the door in the open position for safe access in windy conditions. All access door(s) shall have Allegis type latches and nylon type hinges designed to open

180 degrees. Doors shall open against air pressure as indicated on drawings. Removable panels provided for equipment pull out for coil(s) and heat exchanger(s) shall have key tooled threaded insert fasteners, and have at least one fixed handle on the outside. Access doors shall be sealed with a full "U-Shaped" gasket for superior air tightness along the door edge. Bulb type gaskets shall not be acceptable since they do not return to their original form once compressed.

3. The airflow separation wall between the outside air intake and exhaust air outlet shall be one inch double wall "thermo-composite" panels insulated with minimum R7 foam insulation and Greenguard certified®.)
4. All roof and side wall seams shall be positively sealed to prevent water and air leakage.
5. Outdoor units shall have a rain gutter above each access door and a watertight roof shall be provided with a white TPO UV-reflective membrane. The entire exterior will be finished with (2) two coats of acrylic urethane enamel, manufacturer standard color. Paint shall pass ASTM B117 3000-hour salt fog resistance test and ASTM D4585 3000-hour moisture condensation resistance test. Floor openings shall be covered with 1" fiberglass safety walk-on gratings.
8. Air handler unit casing shall be provided with a lifetime warranty against corrosion resistance under normal use.

I. Enthalpy Wheel

1. Enthalpy Wheel shall recover both sensible and latent heat. The matrix shall be constructed from corrugated aluminum and specifically treated and coated with silica gel desiccant to assist and enhance latent heat transfer. Segmented wheel shall be provided on diameter sizes above 96". Seals shall be full contact, low bleed type, made from dual band Ultra High Molecular Weight Polyethylene. Any seal that is non-contact is not to be considered a seal and will not acceptable. Labyrinth type seals do not operate properly under different air stream pressures therefore shall not be acceptable in any circumstances. Drive system shall be operated by a fractional horsepower motor (maximum 1 HP), reducing gear-box, pulley and v-belt. Belts shall be made of multi-link high-tech urethane/polyester composite. The wheel bearing shall be permanently sealed and press fitted into the wheel matrix for long life operation. A double purge sector (2 x 5º) shall be factory installed to reduce cross contamination to under 0.04%. Frost control prevention shall be accounted for if outdoor air temperatures are below 10 degrees F at equal airflows and return relative humidity below 30%. Manufacturer shall provide and wire a VFD to control wheel speed. ATC shall modulate wheel speed to accomplish frost control per manufacturer's recommendation. Other methods of frost control will not be considered for this application. Wheel speed shall not rotate faster than 20 rpm. Any rotational speed above 20 rpm will be unacceptable. Media cleaning shall be accomplished with any of the following methods: compressed air, low pressure steam, hot water or light detergent without degrading the latent recovery.
   a. Warranty: A standard 5-year material and labor warranty covering all materials supplied and installed.

J. Fans

1. The fans shall be carefully positioned and installed at an optimal distance to respect uniform airflow across the heat exchanger & coil(s).
   a. Plug Fans: Fans shall be direct drive radial centrifugal fans with free running impeller. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating. To reduce vibration, the impeller

shall be balanced with hub to an admissible vibration severity of less than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from galvanized sheet steel. Fans shall have maintenance free ball bearings, closed on both sides, sealed for life. Fans shall be completely certified as per ISO 5801 and in accordance to AMCA standards. Fans will require to be operated by a Variable speed drive. Plug fan shall come equipped with guard grills for the air intake side.

b. The unit manufacturer shall provide flexible connection between fan and fan wall. Flex connection material shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.

c. The fan and motor shall be factory-mounted on a welded structural steel spring type vibration base. The base shall be mounted on stable / adjustable, seismically restrained (seismic zone 2) isolators with 2" maximum deflection rating. Spring efficiency to be not less than 98%.

K. Fan Motors

1. The fan motors shall meet NEMA standard dimensions and comply with the Energy policy Act of 1997. Motors shall have high efficiencies with low noise and vibration output. Motors shall be certified and built in accordance to ISO 9001 quality control system.

2. Motors shall be 1750 or 3600 RPM, 460V/3ph/60 Hz as scheduled and as per the following:

a. Motor shall be premium efficient, ODP enclosure, with cast iron housing and end bells.

b. Motor shall be of HP as listed on schedule and be selected for a minimum of 10% over calculated BHP. The motor service factor shall be a minimum of 1.15.

c. Motor shall be designed for continuous duty operation, NEMA Design B with Class F insulation.

d. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.

1) A shaft grounding brush kit will be provided to prevent electrical damage to motor bearings by safely channeling harmful shaft currents to ground.

e. Provide stainless steel nameplate indicating the following:

f. NEMA efficiency index nominal efficient (MB1-12.53BO).

g. AFBMA bearing numbers.

h. Lubrication instructions.

i. Acceptable motor manufacturers: Reliance, General Electric, Baldor

L. Fan Airflow Balancing

1. Provide the EZ Balancer fan air flow measurement and control system with fan inlet bell air flow measuring taps, electronic controller with digital display of cfm for each fan and transducer.

M. Variable Frequency Drive (VFD)

1. The VFD shall use Insulated Gate Bipolar Transistor (IGBT) technology to convert three phase input power to coded Pulse Width Modulation (PWM) output. The VFD shall be equipped with easy access function for the most

frequently used parameters in HVAC applications. The VFD keypad shall have door mounted status indicators. The VFD shall have monitoring functions to monitor VFD during motor operation. The VFD shall have a carrier frequency that is able to switch the IGBT at 15 kHz. The power terminal strip shall have at least (8) eight digital programmable input terminals. The VFD shall also have programmable output terminals. The VFD shall have 4-20mA analog output terminals that are fully programmable. The VFD shall have the ability to retry automatically after a fault. In the event of a momentary power failure the VFD shall read the inverter speed and direction of a coasting motor and shall restart the motor smoothly. The drive shall have electronic thermal protection settings to protect the motor. The VFD shall have PID function for constant flow applications. The VFD manufacturer shall provide at no charge phone support on VFD. In addition to that, every VFD smaller than 20 hp shall be available in either extender box or integrated enclosure configuration. VFD larger than 20 hp shall be mounted in an integrated enclosure only including the power unit, contactors, relays, and all specified accessories. VFD's shall not have by-pass.

2. Variable frequency drives shall be as manufactured by ABB, Mitsubishi, Cutler-Hammer or approved equal. Per the design intent, all VFD's utilized on this project for HVAC use shall be provided by one manufacturer. ERU manufacturer shall coordinate VFD selection with HVAC sub-contractor.

N. Filters

1. Pre-Filters (Maxi Pleat 2" MERV 8 (25-30%))
   a. Filters shall be factory installed upstream of the heat exchanger and coils, in both airstreams. The air filters shall be Filtration Lab's Maxi-60 MERV 8. Each filter consist of 100% synthetic media, expanded metal on the downstream and enclosing with high wet-strength beverage board with diagonal support bonded on air entering and air exiting side of each pleat. MERV 7 model 415 FILTERS, u.l. class 2 are rated as per ashrae test 52.2.1999 at 55% efficiency initial (based on Minimum Average Efficiency) at 3-10 microns. The model 415 could be operated at 500 fpm, surface area 17.6 FT2 of media based on 24 x 24 x 2 initial static pressure at 0.28" final will be 1". Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.
2. Final (Mega-Pak 4" MERV 13 (85%)
   a. Filters shall be factory installed where shown on the drawings. The air filters shall be Filtration Lab's Mega-Pak MERV 13. Each filter shall consist of 100% synthetic media, expanded metal on the downstream and enclosing frame shall be constructed of a rigid galvanized steel to provide a durable housing for the filter pack. The filter shall have a steel reinforced diagonal support braces affixed on both sides of the filter and it shall have plastic fingers for affixed on both sides of the media pack to control spacing as well to prevent the pleat rows from collapsing one upon the other.

3. Filter Gauge
   a. Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with stainless steel static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank. The filter gauge shall be mounted on the unit exterior.

O. Dampers

1. Dampers shall be installed where shown on the drawings. Dampers shall be low leak type with rubber edges, opposed or parallel blades, and constructed from extruded aluminum. Galvanized dampers will not be acceptable. The exhaust air outlet shall have a standard aluminum gravity type damper, unless otherwise noted below.
2. Dampers shall be installed in the following compartments with linkage rod for actuators:
   a. Outdoor air intake.
   b. Return/Recirculation air damper
   c. Exhaust outlet
   d. Enthalpy wheel bypass dampers (ERU-7&8 only)
3. Actuators shall be 24V factory installed; two-position or modulating type. All actuators shall have spring return mechanism and auxiliary switches.
4. Dampers will be installed in the failed close position unless otherwise noted.

P. Hot Water Heating Coils
1. Hot water coils shall have 5/8" O.D., 0.035" thick copper tubes with helically wound 0.008" thick aluminum fins by Aerofin, Heatcraft or Marlo.
   a. Casing shall be 16-gauge galvanized steel.
   b. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure.
   c. Coil fins shall be flat or rippled fin design, .0075" aluminum. Air pressure drop scheduled shall not be exceeded.
2. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
   a. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
   b. Coil casing shall have removable panel on exterior side.
3. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.
4. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

Q. Chilled Water Cooling Coils
1. Chilled water coils shall have 5/8" O.D., 0.035" thick copper tubes with 0.008" by Aerofin, Heatcraft or Marlo.
   a. Casing shall be continuous stainless steel.
   b. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
   c. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
2. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
   a. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
   b. Coil casing shall have removable panel on exterior side.

3. Each coil tier shall have a welded 16-gauge stainless steel condensate drain pan extending at least 6" in direction of air flow individually piped to unit pan. Provide a minimum pan depth of 3". Pans shall be double sloped IAQ type.
4. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.
5. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.
6. All coils shall be certified in accordance with ARI standard 410.

R. Roof Curb
1. An insulated, pre-fabricated seismic roof curb shall be provided and shipped knocked down. The roof curb will be made of 16-gauge galvanized steel with 4" flanges, minimum 24" high with a factory installed 2" x 3" wood nailer strip.

S. Electrical
1. All electrical and control components shall be wired into a NEMA4 electrical panel and shall be single point power connection.
2. Electrical panel shall include:
   a. High & low voltage wiring with fuse protection
   b. All variable frequency drives
   c. 24 Volt transformers
   d. Lockable non-fused disconnect switch
   e. Laminated electrical, controls and refrigeration diagrams
   f. Air vent to evacuate excess heat
   g. A separate wiring pipe chase for low voltage and high voltage
   h. A drain shall be included in the electrical compartment.
3. Any motors controlled by a VFD shall be wired without the use of contactors and overloads.
4. A UV resistant unit nameplate shall describe unit weight, all electrical requirements, such as FLA, MCA, MOP, and laminated one on the front door and one inside the electrical service compartment.
5. All high voltage wiring shall be copper type tray cable, certified UL1277. Aluminum wiring is not acceptable. All high and low voltage connections shall have water tight connectors.

T. Controls
1. All controls to be by ATC sub-contractor.

U. Service Power & Lighting
1. GFI, lights and switches shall be factory installed and wired to a common junction box. A separate power connection 120/1 will be required (powered by others).
2. Marine Light
   a. A marine light shall be included in the supply fan compartment.

V. Warranty
1. Annexair warrants each product to be free from defects in material and workmanship under normal and proper use, and will within twelve (12) months from date of start-up and not exceed eighteen (18) months from shipment, repair or replace any part which, when returned to our factory transportation charges prepaid, and upon inspection by Annexair, proves to be defective. This warranty does not include any labor or service charges that occur under this warranty. Minimum (5) five year enthalpy wheel warranty shall be provided, parts only –

labor not included.

2. The installing contractor must be responsible for warranty service and maintenance after the equipment is placed into operation.

W. Equipment Start-up

1. The equipment start-up and operational check out is the responsibility of the mechanical contractor who purchased the equipment and associated personnel responsible for its operation. Manufacturer must provide a factory-trained technician who will provide Start-Up Supervision. A written request for Start-Up Supervision must be received a minimum of 2 weeks before expected start-up date in order to schedule it. The mechanical contractor must supply personnel, tools, gauges and instruments to run the equipment. The personnel responsible for the operation of the equipment must be present for the start-up.
2. The energy recovery unit start-up technician shall provide detailed start-up reports summarizing the start-up procedures and results.

X. Weather Hoods

1. The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 45 degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.03 oz/ft2 water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.05" wc at a maximum 450 fpm.
2. Pre-filter rack system shall be installed within the weather hood enclosure to prevent outdoor air dust and debris from entering the damper and unit casing plenum. Filter access in the hood shall be accomplished via the louver that is installed with a stainless steel piano hinge and spring loaded latch. No tools or ladders shall be required to access the pre-filters in the weather hood assembly.
3. The exhaust air outlet louvers shall be 2" extruded aluminum, with non-restricting blade design and bird screen.

Y. OA Airflow Balancing and Monitoring Package

1. An IAQ-TEK probe, transducer and monitor shall be provided and installed in the outside air intake hood to measure OA airflow. Startup and balancing shall be done by the controls contractor.

2.11 EXPANSION JOINTS

A. Expansion joints shall be provided where indicated on the drawings. Equipment shall be as manufactured by Advanced Thermal Systems, ADSCO Division of Yube Industries or approved equal.

B. Expansion joints shall have internal and external guides, fabricated steel body with 150 psig service ratings, single or double slide arrangement to suit the installation location. Bases shall be provided for mounting on framing or to other framing structure. Joints shall have flanged pipe ends on all sizes, polished duplex chrome/nickel plated sleeve sections and entire unit shall be provided with external packing application connections for addition of lubricant under full line pressure. Provide proper packing for both hot and cold lines, together with sufficient spare material and applicator for one year period.

C. Provide guides for expansion joints on the movement side of each expansion joint. Two guides shall be provided prior to each moveable section of expansion joint. Guides shall be ADSCO Model H, for high temperature and Model H-1TB for low temperature lines. Guides shall be located as recommended by the expansion joint supplier for his equipment to minimize lateral misalignment.

D. Provide fintube compensators where indicated on the drawings or every 50 feet on straight fintube runs. Compensators shall be enclosed bellows type with internal guides.

2.12 EXPANSION TANKS

A. Expansion tanks shall be of the types, sizes and capacities indicated on the drawings. Equipment shall be as manufactured by Taco, Bell and Gossett or Thrush.

B. Equipment shall be designed for 125 psig ASME working pressure and so labeled. Tanks shall be provided with gauge glass with tricocks and drain, tank drain, charging valve and mounting saddles or cradles.

C. Bladder-type tanks shall be designed for 125 psig ASME working pressure and be so labeled. Tanks shall be provided with tank drain, charging valve, replaceable bladder, lift ring and base support or cradle. Acceptance capacity shall be the capacity scheduled

2.13 FANS (CENTRIFUGAL)

A. Centrifugal fans mounted in ceiling, wall or with inline duct configuration shall be of the sizes and capacities indicated on the drawings. Fans shall be centrifugal type manufactured by Cook, Greenheck, Acme or Penn Ventilator Company.

B. Fans shall be provided with damper and adapter kit for installing fan with an inline arrangement, where applicable a wall vent, or roof vent cap for installation on an insulated curb provided by the HVAC Contractor.

C. Provide solid state controller to allow full range control of fan speed.

2.14 FANS (DESTRATIFICATION)

A. Provide as shown on the plans, non-power overloading ceiling mounted destratification fan(s). Fan(s) shall be of the specified size, arrangement and capacity. Fan(s) having tip velocities greater or requiring horsepower greater than those identified as the Project Standard will not be acceptable.

B. The fans shall bear the AMCA certified ratings seals for both air and sound performance. Fan ratings shall be based upon tests performed in strict accordance with AMCA Standard 210-67 test code for air moving devices. Each fan shall carry near the manufacturer's nameplate, the seal authorized by AMCA indicating that ratings are certified. Fans not bearing this seal will not be acceptable.

C. Each fan shall have tagging identification engraved on the manufacturer's nameplate. Units shall be manufactured by Leading Edge, Cook or Peerless.

D. Propeller Criteria:
   1. Blades shall be constructed of die formed, aerodynamically contoured steel. Each blade shall have a high tensile steel bracket spot welded in a minimum three (3) point suspension formation, ground smooth following assembly. Bracket shall anchor its blade to the motor rotor assembly using a minimum of two (2) machine screws to support maintainability.
   2. Blades shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer. Blade sets shall be weight matched to within two (2) grams tolerance and shall be statically and dynamically balanced following the

coating and assembly processes.

3. Fans to be installed less than ten feet (10') above the floor shall have rolled edge blades a minimum of 3/16 inches in thickness in conformance with U.L. Standard 507.

E. Motor Criteria:
   1. Each fan motor shall be sized to drive its fan. Whenever starting requirements exceed operating requirements, the motor shall be selected large enough to start the fan without overheating.
   2. No motor shall operate within the service factor range.
   3. Motor shall be of the heavy duty, fixed shaft-rotating housing type carefully matched to the fan load. Motor shall be premium efficiency, 0.91 minimum power factor, poly-phase or single phase as identified on the drawings.
   4. Motor shall be suitable for use with solid state motor speed controllers. Provide embedded automatic-reset type thermal overload protection. Fans to be so labeled in accordance with U.L. Standard 507.
   5. Motor shaft shall be steel bar rod, cold-drawn, minimum 5/8 inches in diameter. Shaft shall incorporate the necessary holes to incorporate down-rod assembly mounting and secondary safety cable mounting simultaneously.

F. Bearings:
   1. Bearings shall be of the self-aligning, heavy duty, permanently sealed and greased chrome steel ball type.
   2. The bearings shall be of sufficient size and quality to have AFBMA B50 rated lives in excess of 100,000 hours at maximum cataloged fan operating conditions.

G. Motor rotor/housing assemblies shall be of formed steel construction, deep drawn to provide air space for motor heat dissipation. Housing shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer.

H. Down-rod Assembly:
   1. Down-rod assembly shall consist of 3/4 inch nominal outer diameter steel pipe finished in epoxy enamel finish over electro-statically applied epoxy powder primer.
   2. Upper shackle shall secure directly to the down-rod, shall consist of nominal 1/8 inch thick formed, plated steel, and shall be rubber bushed to provide a resilient floating suspension for the mounting hook.
   3. Lower yoke shall secure directly to the down-rod and shall consist of nominal 1/8 inch thick formed, plated steel. Yoke shall provide primary support directly to the motor shaft and shall provide space for the secondary support cabling.

I. Fan accessories shall include:
   1. Factory installed secondary support assembly connected to motor shaft with minimum six (6) feet of 1/8 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
   2. Totally enclosing fan guard of twelve (minimum) spoke across bar construction:
      a. Radial Bars – 5 gauge.
      b. Circumferential Bars – 5 gauge on three (3) inch centers.
      c. Heavy duty 16 gauge mounting brackets shall secure the fan guard assembly directly to the fan down rod assembly. Provide a secondary support assembly connected to fan guard mounting brackets with minimum six (6) feet of 3/32 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
   3. U.L. listed solid state motor speed controller shall incorporate infinite speed control with positive "Off" position. Controller shall incorporate 8 ampere rated (minimum triacs and solid copper wire toroidal choke-type RFI suppression

circuitry.

2.15 FANS (ROOF)

A. Roof exhaust fans shall be of the centrifugal belt-driven or direct-drive type as indicated on drawings. Fans shall be of capacities and characteristics as scheduled on drawings and specified herein. Fans shall be as manufactured by Greenheck, Cook or Penn Ventilator Company.

B. Construction of the fan housing shall be of heavy-gauge aluminum.

C. All spun parts shall have a rolled bead for added rigidity and shall be specially spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.

D. The fan wheel shall be all-aluminum of the centrifugal blower type featuring backward-inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced. Inlet cone shall be aluminum and of the centrifugal blower type. Motor and drives shall be enclosed in a weathertight compartment, separate from the exhaust air stream. Air for cooling the motor shall be supplied to the motor compartment by way of an air passage from an area free of contaminated exhaust fumes. Motors shall be of the duty, permanently lubricated, sealed ball-bearing type. Drives shall be sized for 165 percent of motor horsepower capabilities and of the cast-iron type, keyed to the fan and motor shafts. Variable pitch drives shall be standard. Fan shall be of steel construction, turned, ground, and polished to precise tolerances in relationship to the hub and bearings. Drive belts shall be of the oil-resistant, non-static, non-sparking type with life expectancy of 24,000 hours.

E. Bearings shall be flanged and of the permanently lubricated, permanently sealed, ball-bearing type capable of over 200,000 hours bearing life. The entire drive assembly and wheel shall be removable as a complete unit, from the support structure without disassembling the external fan housing. The complete drive assembly shall be mounted on rubber vibration isolation.

F. Direct drive units shall be of identical construction as belt drive units, except for drives, belts, and fan shaft bearings.

G. Fans shall be licensed to bear the AMCA ratings seal for air and sound performance.

H. Fans shall be furnished with pre-fabricated 18 inch high roof curbs. Roof curbs shall have 2 inch raised cant strip and wood nailer. Curb shall be aluminum construction with all seams continuously welded the entire length. Curbs shall meet the one “G” acceleration criteria. Fans shall be furnished with automatic motor operated damper.

I. Provide solid state speed controller as a disconnect for direct drive fans, pre-wired and mounted. Provide pre-wired and mounted disconnect switch on belt drive fans.

2.16 FAN (FUME HOOD EXHAUST)

A. General
1. Base fan performance at standard conditions (density 0.075 Lb/ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be belt driven.
4. Fans to be equipped with lifting lugs.
5. Fan to be coated steel with a minimum of 4 mils of Hi-Pro Polyester Resin.

Color to be gray.

6. Fasteners to be stainless steel.
7. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

B. Fan Housing and Outlet

1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan housing shall be welded steel with a minimum of 4 mils of Hi-Pro Polyester Resin. No uncoated metal fan parts shall be acceptable.
3. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
4. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
5. Provide housing drain for removal of rain and condensation.
6. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
7. Standard finish color to be gray.

C. Fan Impeller

1. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
2. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and coated with a minimum of 4 mils of Hi-Pro Polyester resin.

D. Fan Bypass Air Plenum

1. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum.
2. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
3. A fan isolation damper, either gravity back draft or two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro Polyester resin, electro-statically applied and baked, shall be provided as shown on the project documents.
4. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

E. Fan Motors and Drive

1. Motors to be premium efficiency, standard NEMA frame, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
2. Drive belts and sheaves shall be sized for 150% of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
3. Shaft to be polished and ground steel.

4. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
5. Bearings shall have extended lube lines with Zerk fittings.

F. Manufacturer
1. Greenheck Fan Corp, Model Vektor-H High Plume Laboratory exhaust system or approved equal.

2.17 FANCOIL UNITS

A. Furnish and install fancoil units where shown on the drawings and to the sizes and capacities as indicated in the schedule. Fancoil units shall be as manufactured by McQuay, American Air Filter, Carrier, or approved equal.

B. Performance Data:
1. Unit capacities shall be certified in accordance with ARI Standard 441-70.
2. Units shall be sound tested and rated in accordance with ARI Standard 443-70.
3. Unit shall comply with National Electrical Code and approved by Underwriter's Laboratories.

C. Basic unit includes chassis, coil, heavy-density faced-glass fiber insulation, air block-offs around coil, removable fan board/drain pan assembly, auxiliary drain pan, fan, fan housing, motor and filter. Chassis shall be of galvanized steel of molded, high impact thermoplastic with solderless connection (7/8 inch OD copper tubes). Unit shall have one-piece box construction pedestal base riveted to chassis.

D. Coils: 5/8 inch OD seamless copper tubes mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved coil end supports. Maximum working pressure 300 psig, factory burst test 450 psi (air) and leak test 300 psi (air under water). Maximum entering water shall be 275 degrees F. Coils shall have female sweat connections to accept 5/8 inch OD copper tubing.

E. Auxiliary Heating Coils (L): 7/16 inch OD copper tubes mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved end supports. Maximum working pressure 200 psig. Maximum entering water 220 degrees F. Female sweat connections to accept 1/2 inch OD copper tubing.

F. Drain Pans: Vertical main drain pans shall be galvanized steel with molded, one-piece self-extinguishing polystyrene foam insulating liner.

G. Fans: Fan wheels centrifugal forward-curved, double width of molded, reinforced glass fiber material. Fan wheels and housings corrosion resistant. Fan housings of formed sheet steel.

H. Motors: High efficiency permanent split capacitor motors shall not exceed scheduled amperage, shall have integral thermal overload protection and start at 78 percent of rated voltage. Motors shall operate satisfactorily at 90 percent of rated voltage on all speed settings and at 10 percent over voltage without undue magnetic noise. Temperature rise

by winding resistance method shall not exceed 60°C. (shaded pole) and 50°C (psc) on high speed and 65°C. (shaded pole) and 55°C. (psc) on reduced speeds.

CFM	AMPS AT HIGH SPEED
200	0.55
300	0.60
400	0.55
600	0.80

All motors shall be factory run tested in assembled unit prior to shipping.

Motor cords shall be quickly detachable at switch box by locking prolonged connector (optional on horizontal units).

I. Filters: Concealed from site and removable from vertical models without displacing front panels. Filters shall be throw-away type of woven glass fiber.

J. Extended Motor Oilers: Plastic tubes shall terminate beneath discharge grille of vertical cabinet models. Tube openings shall be covered.

K. Piping Package: The piping package shall be arranged to pipe the two coils from the same end. Piping package shall be complete with four stop valves and automatic air vents for each coil. Piping package shall be completely factory mounted including two (2) three-way control valves of same manufacture as the automatic temperature control system.

L. Controls: Each unit shall have a factory-mounted and wired three-speed on/off switch.

2.18 FILTERS

A. MERV 11
1. Air Filters shall be Model Pre Pleat 62RM11 panel filters, as manufactured by Flanders Precisionaire or approved equal.
2. Each filter shall consist of an electrostatically charged synthetic only media, with corrosion-resistant expanded metal backing and moisture resistant enclosing frame. The filter shall be 1”, 2” or 4” nominal depth. The grid shall be 100% bonded to the media on the air exiting side to eliminate media vibration and pull away.
3. The grid shall be formed to provide a uniform V-wedge shaped pleat with the open area on the air exiting side for maximum utilization of the media and low airflow resistance. The filter shall be classified for flammability by Underwriters Laboratories, Standard 900 as Class 2.
4. The filter shall have a Minimum Efficiency Reporting Value of 11 by ASHRAE Standard 52.2.

B. MERV 13
1. Air Filters shall be Model Dominator High Efficiency Rigid Cell Extended Surface Filter, as manufactured by Purolator or approved equal.
2. Each filter shall consist of 100% synthetic media. The cell sides shall be high strength, high impact polystyrene plastic and the entire filter shall be completely incinerable. The filter shall be 4” nominal depth.
3. The filter shall be classified by Underwriters Laboratories, Standard 900 as Class 1.
4. The filter shall have a Minimum Efficiency Reporting Value of 13 by ASHRAE Standard 52.2.

2.19 FINTUBE RADIATION

A. Fintube radiation shall be of the types, sizes and capacities indicated on the drawings. Fintube elements, brackets, hanging strips, floor angles and enclosure panels shall be as manufactured by Vulcan, Sterling, Rosemex or Rittling.

B. Fintube radiation covers shall be as detailed on the drawings. They shall run continuous wall to wall, except where otherwise indicated on the drawings.

C. Fintube shall extend the full width at walls with square end caps at columns. Enclosure covers shall have hinged access panels for valving.

D. Fintube elements shall be steel tube, steel fins, 4¼ inch, 40 fins per linear foot, except where noted otherwise.

E. Wall mounted type enclosure mounted in front of glazing shall have full backplate.

F. Fintube enclosures shall be factory finished. Color to be determined by Architect.

2.20 FOUNDATIONS AND SUPPORTS

A. All mechanical equipment and systems shall be substantially supported without distortion or excessive vibration. The methods of support shall be as hereinafter described, except as otherwise noted on the drawings. This Contractor shall locate all equipment bases and shall provide all anchor bolts and templates to the General Contractor who shall form and set all concrete work and shall set all anchor bolts. Anchor bolts and nuts shall be galvanized.

B. Concrete housekeeping pads shall follow equipment plan shape and be 6 inches in height. Where equipment is set directly on housekeeping pads the space between equipment base and pad top shall be filled by the General Contractor with non-shrinking grout. Where equipment shape or mounting is such as to require an air space between equipment bases and pad, the pad shall then be furnished with a smooth troweled surface. All equipment shall be anchored to housekeeping pads or all intervening vibration isolator bases shall be anchored to the structure.

C. Where steel frame floor supports are indicated to be provided, such framing shall be all-welded type with two coats of red primer. The framing system shall be substantial type with members sized to prevent equipment distortion or excessive vibration. Framing shall be simple post and beam box type with diagonal bracing to prevent lateral movement. Beam members shall be positioned to align with equipment support points for proper bolting and posts shall be positioned to prevent excessive beam cantilevering. Posts shall be provided with baseplate anchored to the structure.

D. Where steel framing supports are indicated to be provided for roof mounted equipment (those without integral curbs for setting into roof structure) the same framing system as described above shall be used, except members shall be galvanized and bolted together. Posts shall be positioned to align both framing and roof structural members with pitch pockets at roof penetrations.

E. Ground-mounted equipment shall be supported with framing system similar to roofing application described above except that posts shall be set on poured-in-place concrete piers with galvanized anchor bolts. Concrete piers shall be provided by the General Contractor.

2.21 GRAVITY VENTILATORS

A. Gravity ventilators shall be roof mounted air intake louver houses as manufactured by Cook, Greenheck, or Penn Ventilator Company.

B. Louver houses shall have heavy gauge extruded 6063-T5 aluminum blade of the storm blade style with corners metered and welded. Roof and curb caps shall be formed of minimum 0.051 gauge aluminum unit base to be minimum 0.080 gauge. The entire assembly braced by heavy mill gauge galvanized steel interior upright angles at the corners and along the sides. Manufacturer's catalog ratings shall be based upon tests conducted in an industry approved testing laboratory with air volumes and losses as shown.

C. Per ANSI-A58.1 testing standards, each ventilator must be rated for 100 MPH wind load and 101.5 lbs. per square foot snow load.

D. Furnish 1/2" thick sprayed on plastic coating to eliminate condensation on underside of roof. Intake ventilators to be 200% free area. Relief vents to be 150% free area.

E. All seams to be continuously welded. Equip all ventilators with aluminum bird screen.
   1. Provide a roof curb of matching construction details, coordinated with the roof construction within which it is to be installed. Curb shall be equipped with a two position, electrically driven damper at the integral utility shelf within the curb, for each gravity ventilator.

F. Provide entire aluminum assemblies in three-coar, fluoropolymer color, to be selected by the Architect from manufacturer's standard range of colors and gloss.
   1. Surfaces to be acid chromate-fluoride-phosphate pre-treated.
   2. Provide manufacturer's standard three-coat, thermo-cured system composed of specially formulated inhibitive primer, fluorocarbon color coat and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinyl resin by weight; complying with AAMA 605.2.
   3. Provide with five (5) year warrantee.

2.22 HOT WATER REHEAT COILS

A. Hot water reheat coils shall be of the sizes and capacities indicated on the drawings. Coils shall be as manufactured by Heatcraft, McQuay, Trane or Carrier.

B. Coils shall be ARI rated and suitable for 250 psig test pressures.

C. Coils shall be constructed with welded steel headers, staggered copper tubes with spirally wound mechanically bonded aluminum fins. Coils shall be provided with mounting flanges for insertion into the ductwork. Independently support all coils.

2.23 INSULATION MATERIALS (GENERAL REQUIREMENTS)

A. All insulation materials to be furnished for installation under this section shall be as manufactured by Owens-Corning, Certainteed, Knauf, or Schiller Company.

B. Shop drawings shall be submitted for all insulation system materials to be furnished for installation under this section. Submittals shall include descriptions of the application of all materials to be used for each insulation class and catalog cuts of all materials furnished.

C. All insulation materials to be furnished for installation under this section shall conform to fuel contributed flame spread and smoke developed limits set forth in NFPA Standard 90A as determined by NFPA 255, ASTM E84 or UL723 tests.

2.24 INSULATION MATERIALS (EQUIPMENT)

A. Equipment shall be insulated as specified and as indicated on the drawings.

B. Insulation shall be applied to equipment in accordance with insulation class. Thickness and special jacketing indicated below.

Hot water heat exchangers, hot water expansion tanks, and hot water air separators shall have 1½ inch thick Class 142 insulation.

Chilled water expansion tanks, chiller chilled water boxes shall have 1½ inch thick Class 141 insulation.

Chilled water pumps shall have 2 inch thick Class 141 insulation segmented to permit pump servicing without damaging insulation. Hot water pumps shall have Class 141 insulation same as chilled water pumps.

Class 141

Insulation shall consist of minimum 6 pound rigid fiberglass blocks cut to fit equipment shape and secured with 1/8 inch annealed steel wire anchored with pins attached to equipment surface to prevent sagging.

Over insulation tightly stretch wire lath, wired and anchored securely in place with all edges tied to prevent lifting and separating. Over lath apply 1/2 inch thick insulating cement plaster in two coats consisting of scratch and troweled smooth finish coat. Finish shall consist of two (2) 1/8 inch thick coats of vapor seal adhesive with intermediate glass fabric reinforcing with smooth finish.

Class 142

Insulation shall consist of minimum 6 pound rigid fiberglass blocks cut to fit equipment shape and secured with 20 gauge annealed steel wire or bands. Voids and seams shall be filled using insulating cement. Over insulation tightly stretch wire lath, wired and anchored securely in place with all edges tied to prevent lifting and separating. Over lath apply 1/2 inch thick insulating cement plaster in two coats consisting of scratch and troweled smooth finish coat. Finish shall consist of 6 ounce canvas jacket trimmed to fit, tightly wrapped, sized and secured with lagging adhesive.

2.25 INSULATION (PIPING)

A. Piping systems shall be insulated as specified herein and as indicated on the drawings.

Fluid	Fluid Temp. Range F.	Run-outs Up to 1”	≤ 1.5”	> 1.5”	Class
Hot Water	105-200	1/2	1½	2	104
Chilled Water	40-55	1/2	1½	1½	104
Coil Drains	Any	3/4	3/4	3/4	Inside 104 Outside 107

Run-outs not exceeding twelve (12) inches in length

Note: Provide 0.016 inch thickness embossed aluminum protective jacketing on all insulated piping within mechanical rooms within 6 feet of floors.

B. Insulation shall be omitted from the following piping:
1. Equipment vent piping.
2. Equipment drain piping beyond shut off valve.

3. Steam coil condensate piping from equipment outlets to steam trap.
4. Compressed air piping.
5. Piping within fintube covers.
6. Heat pump loops.

C. Engine exhaust piping, fittings and silencers shall be covered with 4 inch calcium silicate insulation. Insulation shall be applied in two (2) layers with staggered joints. Secure insulation in place with heavy gauge stainless steel bands. Seal all seams and joints in each layer with high temperature cement. Cover insulation with reinforced glass fiber cloth.

Class 104
Piping: Insulation shall consist of high density (minimum #4) molded fiberglass sectional pipe insulation with a minimum R value of 4.0 H. degrees F. ft.²/BTU per inch, with factory applied all-service jacket with vapor barrier, butt and lap end strips shall be self-sealing or secured with vapor seal adhesive.

Fittings, Valves and Flanges: 2 inch size and smaller shall be insulated with 1 pound density and secured with 20 gauge annealed steel wire. Then apply insulating and finish cement to match the adjacent pipe insulation thickness and then have two (2) 1/8 inch thick smoothing and finishing coats of vapor seal adhesive applied using intermediate glass fabric reinforcing. Vapor seal adhesive shall lap adjacent pipe cover. Fittings may be insulated with two layers of fiberglass with PVC covers.

Valves, Fittings and Flanges: 2½ inch size and larger shall be insulated using sections of high density fiberglass molded sectional pipe insulation cut to fit, secured with 20 gauge annealed steel wire. All voids and pockets shall then be filled with insulating cement and finish cement. Finish shall be two 1/8 inch thick smoothing and finishing coats of vapor seal adhesive applied using intermediate glass fabric reinforcing. Vapor seal adhesive shall alp adjacent pipe cover.

Class 107
Tubing and Piping: Insulation shall consist of flexible type foamed plastic pipe insulation with flame spread rating of 25 or less and smoke development rating of 50 or less per ASTM E84-75 test, integral vapor barrier. Insulation shall be slit type, field sealed with companion adhesive.

Fittings, Valves and Flanges: Tubing Systems – Fittings shall be made by miter cutting of adjacent straight piping runs and sealing joints with companion adhesive. Valves shall be insulated by using a combination of nested pipe insulation and sheets to form a complete enclosure with all joints sealed with companion adhesive. Flanges shall be insulated by using sheets cut to fit pipe side of flange and wrapping sheets around flange perimeter. All joints shall be sealed using companion adhesive. Piping Systems – Fittings shall be insulated using nested sections of pipe insulation mitered to form a square corner and sealing joints with companion adhesive. Valves and flanges shall be insulated as described for tubing systems.

D. PVC Piping Insulation Cover:
1. Piping insulation cover shall be of nominal thirty (30) mil UV stabilized PVC preformed to appropriate shapes for straight piping, fittings, valves and accessories. Solvent welding type adhesive shall form a permanent chemical bond between surfaces and shall present a continuous vapor barrier across the joint. PVC piping insulation cover shall incorporate the following characteristics.

Typical Properties	**Test Method**	**Value**
Service Range	N.A.	0°F. to 150°F

Specific Gravity	ASTM D-792	1.48
Flame Spread	ASTM E-84-97a	25
Smoke Developed	ASTM E-84-97a	50

Typical Properties	**Test Method**	**Value**
Flexural Strength	ASTM D-638	11,500 psi
Tensile Modulus	ASTM D-638	470,000 psi
Elongation at Yield	ASTM D-638	3% MD
Flexural Modulus	ASTM E-790	460,000 psi
Electrical Conductance	D-257	Non-conductor
Gardner-SPI Impact	D-3679	8 lb/mil (30 mil sample)
Abrasion	Taber Method	10,000 revolutions, CS-17 wheel, 1,000 gr weight
Water Vapor Transmission	ASTM E96-95	0.009 perms

2.26 INSULATION (SHEET METAL)

A. Sheet metal work shall be insulated as specified herein and as indicated on the drawings.

B. Insulation shall be applied to the following:
1. All air conditioning systems ductwork and associated equipment exposed to view; all systems outside air plenums, ducts and louver boxes; all system exhaust air plenums, ducts and louver boxes from louver connections back to automatic dampers. All portions of heating and ventilating and air conditioning unit casings not internally insulated, all air conditioning systems return air fans and all equipment shall have Class 131 insulation.
2. All concealed air conditioning system supply and return air ductwork and associated equipment including terminal box reheat coil casings, shall have Class 135 insulation.
3. Insulation liner shall be provided where indicated on the drawings. Refer to sheet metal work.
4. All sound attenuators in insulated system ductwork shall be insulated. Sound attenuator sections furnished with Rooftop air handling units shall be insulated in field when not furnished insulated by the unit manufacturer.

C. Kitchen grease ductwork shall have 3 inch Class 130 insulation.

D. Insulation shall be omitted from the following sheet metal work:
1. Toilet, locker and storage exhaust ductwork except where noted on drawings.

E. All louver plenums, louver blank-off plates and ductwork which will conduct air shall have insulation thickness increased to a minimum of 2 inches or as indicated on drawings.

F. All supply and return ductwork located outside shall have rigid board insulation with thickness increased to a minimum of 3 inches and be provided with a weatherproof cover in addition to the vapor barrier.
1. Class 130
a. Insulation shall consist of a UL listed duct wrap system complying with UL 1978 and ASTM E-119. Blanket material shall be in alumina (45% ±) composite incorporating the following characteristics.
b. Service Range: 0°F to 2300°F
c. Melting Point: 3200°F

d. R Value @ 70°F: $4.5\frac{Hr.Sq.Ft.°F.Inch}{BTU}$

e. R Value @ 283°F: $9.9\frac{Hr.Sq.Ft.°F.Inch}{BTU}$

f. Flame Spread: 5 (ASTM E84/UL-723)

g. Smoke Developed: 5 (ASTM E84/UL-723)

h. The blanket shall have a foil facing, adhered to the blanket mat, incorporating the following characteristics:

i. Tensile Strength: M.D. 40#/IN (ASTM D-828)
C.D. 40#/IN (ASTM D-828)

j. Puncture Resistance: 100 Units (Min) (ASTM D-781)

k. Self adhesive filament tape shall be of the high performance type equal to 3M Company *898.

l. Banding material, 3/4" wide, minimum 0.015" thick, carbon steel for construction requirements of zero clearance to combustibles or 1 hour ratings. Stainless steel banding shall be used for 2 hour requirements (SS wire ties or 1/4" SS hose clamps may be substituted for hanger insulation only).

m. Tensioning tool for banding material manufactured by Okle or by Signoide Company; seals such as those manufactured by Okle or by Signode Company; and crimping tool such as those manufactured by Okle or Signode.

n. 10 gauge, 4" to 5" long, copper coated steel pins; 1½" x 1½" galvanized steel speed clips; capacitor discharge stud gun (110/115) such as that manufactured by AGM.

o. Grease duct access door hardware; 4½" x 5" long, 1/4" wing nuts and 1/4" metal washers; 4" long steel hollow tubing to fit threaded rods.

2. Class 131

a. Insulation shall consist of 1½ inch thick minimum 4 pound density rigid fiberglass board with reinforced foil vapor barrier cut to fit duct shape and applied by impaling insulation on pins attached to duct surface. Pins shall be located approximately 1 per square foot of surface. Insulation shall be secured on pins using metal washers with excess pin length trimmed. Seal seams and all vapor barrier penetrations using 4 inch wide reinforced foil tape self-sealing type or secured using vapor seal adhesive.

b. Note: Flanges protruding from sheet metal shall be covered with 4 inch wide insulation board strips and sealed with 4 inch wide reinforced tape secured with vapor seal adhesive.

c. Finish shall consist of pre-sized glass fabric jacket applied to insulation surface and secured with lagging adhesive. All plenums and ducts within 5 feet of floors shall have edges reinforced with metal corner beads applied to insulation and sealed with 4 inch reinforced foil tape secured with vapor seal adhesive prior to finish.

3. Class 135

a. Insulation shall consist of minimum 1½ inch thick flexible fiberglass blanket with reinforced foil vapor barrier. Insulation shall be tightly wrapped around duct and secured using bonding adhesive covering not less than 50 percent of sheet metal surface. Seams and penetrations shall be sealed by using 4 inch wide reinforced foil tape self-sealing type or secured with vapor seal adhesive. The bottom of ducts over 24 inches wide shall have additional support for blanket consisting of pins attached to duct surface at a rate of 1 per 2 square feet, evenly spaced.

Insulation shall be impaled on pins and secured using mechanical washers with excess pin length trimmed.

G. Ductwork Weatherproof Insulation Cover:

1. Weatherproof insulation cover shall be a self-adhering roll-type roofing membrane consisting of a laminated assembly of aluminum facing, two (2) layers of styrene-buadiene-styrene and a nominal forty (40) mil layer of rubberized asphalt adhesive. Asphalt adhesive compound shall be pressure sensitive, protected by a release paper u ntil installation. Composite assembly shall incorporate the following characteristics.

Typical Properties	**Test Method**	**Value**
Service Range	N.A.	-25°F. to 150°F.
Heat Aging	ASTM D-794	No visible blistering, de-lamination or deterioration
Flame Spread	ASTM E-84-97a	0 (NFPA Class “A”)
Smoke Density	ASTM E-84-97a	5
Tear Strength	ASTM D-1424	680 gr MD 640 gr CD
Tensile Strength	ASTM D-1000	500 p si MD 625 psi CD
Elongation	ASTM D-1000	296% MD 228% CD
Static Uplift	ASTM E-907	No damage or failure evident @ 75 psf for 1 minute
Wind Driven Rain	South Florida Test 5683	No leakage, damage or failures evident @ 100 MPH
Lap Joint Tensile Strength	MFM Method	Exceeds material strength
Lap Joint Peel Strength	MFM Method	11 lb/in (180° angle)
Abrasion	Taber Method	10,000 revolutions, CS-17 wheel, 1,000 gr weight
Low Temperature Flexibility	MFM Method	100,000 cycles @ 10°F with no cracking
Q-U-C Accelerated Weathering	Q Panel Co. UV Chamber per Rubber Manufacturer’s Association	4,000 hr exposure surface and lap joints, no effect
Reflectivity	Photo-volt meter	129 (black surface ≈ 29)
Water Vapor Transmission	ASTM E96-95	0.009 perms

2.27 MAKE-UP AIR UNIT (INDIRECT GAS FIRED)

A. Provide factory fabricated H&V units in the sizes and capacities as identified on the drawings. Units shall be indirect fired by natural gas, shall draw combustion air in through a dedicated vent and shall discharge products of combustion through a dedicated vent. Units shall be as manufactured by Reznor, Greenheck or Sterling.

B. Equipment casings shall be sectional type factory assembled of indicated manufacturer’s

standard design for system static pressures. Casings shall be provided with galvanized or baked enamel corrosion resisting finish. Individual sections shall be bolted together utilizing gaskets and then mastic sealed. All sections shall have 1 inch thick fiberglass lining secured using adhesive and provided with air side air erosion coating. Provide access doors to all fan sections and furnace sections.

C. Units shall be mounted from four point lifting and anchor holes suitable for suspension mounting, in accordance with manufacturer's instructions.

D. Mixing shall occur directly within the blower section. Mixing system shall have parallel bladed return and outside air dampers with active sections sized to produce 1,200 FPM to 1500 FPM through either section at design air flow. Where excessive damper blades are provided, blank off the furthest blade. Dampered openings shall be arranged at right angles to one another with two (2) sets of parallel blades forcing the two air streams together. Outside air dampers shall be gasketed.

E. Filter sections shall be field fabricated as separate sections as indicated on the drawings. Filters shall be low velocity type except as indicated otherwise on the drawings and shall be 4 inch MERV 11 type. Filter shall be mounted in metal holding frames accessible from either side of the casing. Provide three (3) spare sets of filters.

F. Heat exchanger(s) construction shall consist of 20 gauge (minimum), Type 409 stainless steel tubes, seams electric resistance welded, with 20 gauge (minimum) Type 409 stainless steel headers.

G. Burners shall be die-formed with stamped porting and stainless steel port protectors to prevent scale or foreign matter from obstructing the burner ports. Burner construction shall consist of Type 409 stainless steel, seams electric resistance welded.
   1. Burners must be individually removable for cleaning and servicing. The entire burner assembly must be easily removable with a slide-out drawer design. The pilot must be accessible through a pilot access plate without removing the burner assembly.

H. Venting shall occur through a power type separated combustion system as identified on the drawings.
   1. Flue collector construction shall consist of Type 409 stainless steel, seams electric resistance welded.
   2. Air for combustion shall be entrained through a dedicated combustion air inlet vent by an integral vent fan designed for the furnace size it serves. Vent shall terminate through a factory fabricated intake. Combustion air shall be precisely metered in accord with the required firing rate to produce appropriate fuel-air combinations for optimum combustion efficiency.
   3. Products of combustion shall be discharged through a dedicated flue gases vent. Vent shall terminate through a factory fabricated exhaust terminal a minimum of twenty-four inches (24") above the nearest construction within a ten foot (10'0") radius and a minimum of eighteen inches (18") above the combustion air inlet.
   4. Combustion air inlet vent and flue gases vent shall run independently from the furnace to a factory fabricated concentric adapter. The adapter shall form the combustion air inlet vent into a concentric sleeve around the flue gases vent. The two concentrically oriented vents shall run together to their respective coaxial terminations.

I. Units shall be provided with gas valves suitable for Class 2, maximum inlet pressure of 0.5 psig (14 inch wc) on natural gas. The low voltage combination automatic gas valves must include:

1. Main operating valve.
2. Pilot safety shut off.
3. Pressure regulator.
4. Manual main shut off valve.
5. Manual pilot shut off valve.
6. Adjustable pilot valve.
7. Gas valves shall be of the electronic type providing modulated heat output. Ignition shall be at full fire (100 percent input). The gas valve shall modulate from 100% rated input to 50% rated input.

J. The solid state ignition control system shall ignite the required pilot(s) by direct spark during each cycle of operation. When pilot flame(s) are proven, main burner valve(s) shall open to allow gas flow to the burners. Pilot(s) and burner(s) must be extinguished during the “Off” cycle.

K. Fan sections for low pressure service shall have forward curved fan wheels, except where specifically noted otherwise. All fan wheels shall be statically and dynamically balanced and so designed that the first critical speed is not less than 20 percent beyond the indicated operating space. Fan bearings shall be grease lubricated type with extended grease nipple. Fans shall have V-belt drives with motors mounted on adjustable slide bases. Motors shall have adjustable sheaves. V-belt drives shall have belt guards with hole at fan shaft for tachometer readings. Unit shall have rubber vibration isolator rails.

L. Supply fan motors shall open drip proof (ODP) design, premium efficiency, and inverter rated.
1. Motors shall be provided with internal thermal overload protection, external overload protection with heaters, or magnetic starters. Motors 1/2 horsepower and larger shall be suitable for poly-phase electric service.
2. Motor wiring shall be enclosed in 1/2 inch Greenfield cable.
3. Supply fan motors shall be activated through a magnetic starter.

M. A factory installed and wired single point power connection junction box shall feed a factory installed and wired control box including any necessary control service transformers, high limits, and fan delay relays. The fan delay relay shall delay the fan start until the heat exchanger reaches a pre-determined, factory set temperature. The fan delay relay shall require the fan to operate after burner shut-down to remove residual heat from the heat exchanger.

N. Factory installed options shall include:
1. 120 volt convenience outlet.
2. Firestat to shut unit down and notify all fire alarm functions if discharge air reaches a factory preset temperature. Firestat shall require manual reset.
3. Factory mounted and wired variable frequency drive with P.I.D. control.
4. Disconnect switch.

O. Field installed options shall include:
1. High gas service pressure regulator, to reduce the main gas line pressure from a maximum of 125 psig to a minimum of 5 inches water column.
2. One main set and two spare sets of filters.
3. Clogged filter switch shall sense the suction pressure increase incurred by the blower due to filter obstruction. Switch shall indicate in the blower compartment and shall incorporate normally-open contacts for remote notification.
4. Roof mounting curb for equipment scheduled for roof mounting.

P. Provide flexible braided stainless pipe connectors at least 12 inches long in each piping connection to the unit.

Q. Submittals shall show operating characteristics of each equipment section and note all operation data indicated on the drawings for the actual equipment selections. Also provide individual assembly drawings for Rooftop air handling unit showing sequence of sections and all accessories furnished as part of the equipment. Individual unit sound power levels shall be separately tabulated together with scheduled design limitations.

2.28 MOTORS

A. This section identifies basic requirements for motors. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

B. Quality Assurance:
1. Comply with NFPA 70 “National Electrical Code”.
2. NRTL Listing: Provide NRTL listed motors.
   a. Term “Listed”: As defined in “National Electrical Code”, Article 100.
   b. Listing Agency Qualifications: “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
3. Comply with NEMA MG 1: “Motors and Generators”.
4. Comply with UL 1004: “Motors, Electric”.

C. All motors provided for this project shall comply with the requirements of this section, except as otherwise indicated.
1. Motors 1/2 HP and Larger: Polyphase
2. Motors Smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
   a. 120V Circuit: 115 V – motor rating.
   b. 208V Circuit: 200 V – motor rating
   c. 240V Circuit: 230 V – motor rating.
   d. 480V Circuit: 460 V – motor rating.
5. Service factors indicated for motors are minimum values and apply at frequency and utilizing voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
6. Capacity: Sufficient to start and operate connected leads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
7. Temperature Rise: Based on 40 degree C. ambient except as otherwise indicated.
   a. Enclosure: Totally Enclosed Air Over

D. Polyphase Motors:
1. General: Squirrel-cage induction type conforming to the following requirements except as otherwise indicated.
   a. NEMA Design Letter Designation: “A” or “B”
2. Multi-Speed Motors: Separate winding for each speed.
3. Premium Efficiency Motors: Nominal efficiency equal to or greater than that stated in NEMA Standard Publication MG 1-2003, Tables 12-12 and 12-13 respectively.
4. Variable speed motors for use with solid-state drives: Energy efficient, squirrel-cage induction, design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer.
5. Internal thermal overload protection for motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
6. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application.
7. Rugged Duty Motors: Totally enclosed with 1.25 minimum service factor.

Provide motors with regreasable bearings and equipped with capped relief vents. Insulate windings with nonhygroscopic material. External finish shall be chemical resistant paint over corrosion resistant primer. Provide integral condensate drains.

8. Motors for reduced in-rush starting: Coordinate with indicated reduced in-rush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

E. Single-Phase Motors:
   1. General: Conform to the following requirements except as otherwise indicated.
   2. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application:
      a. Permanent Split Capacitor
      b. Split-Phase Start, Capacitor-Run
      c. Capacitor-Start, Capacitor-Run
   3. Shaded-Pole Motors: Use only for motors smaller than 1/20 HP.
   4. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
   5. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

2.29 PIPE, HANGERS, SUPPORTS AND ANCHORS

A. Provide all necessary labor, supervision, materials, equipment and services required to furnish and install all pipe supports, hangers, anchors and other suitable supporting appliances necessary to support firmly and substantially all parts of the apparatus described in this specification. Equipment shall be as manufactured by B-Line, Uni-Strut, Grinnell or Carpenter & Patterson.
   1. Pipe shall be adequately supported by pipe hanger and supports and restrained by anchors. Hangers for insulated pipes shall be sized to accommodate insulation thickness.

B. Steel pipe hangers, anchors and supports shall have the manufacturer's name, part number, and applicable size stamped into each part for identification.

C. Hangers, anchors and supports shall be designed and manufactured in conformance with the following standards as appropriate.
   1. ASTM B633: Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
   2. ASTM A123: Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip
   3. ASTM A653 G90: Manufacturers Standardization Society: Pipe Hangers and Supports – Materials, Design and Manufacture
   4. MSS SP69: Manufacturers Standardization Society: Pipe Hangers and Supports – Selection and Application

D. Hangers:
   1. Uninsulated pipes 2 inches and smaller:
      a. Adjustable steel swivel ring (band type) hanger.

b. Adjustable steel swivel J-hanger.
c. Malleable iron ring hanger or hinged ring hanger.
d. Malleable iron split-ring hanger with eye socket.
e. Adjustable steel clevis hanger.

2. Uninsulated pipes 2½ inches and larger.
   a. Adjustable steel clevis hanger.
   b. Pipe roll with sockets.
   c. Adjustable steel yoke pipe roll.
3. Insulated Pipe – Hot Services (including steam piping):
   a. 2 Inch and Smaller Pipes:
      i. Adjustable steel clevis with galvanized sheet metal shield.
   b. 2½ Inch and Larger Pipes:
      i. Adjustable steel yoke pipe roll with pipe covering protection.
      ii. Pipe roll with sockets with pipe covering protection saddle.
4. Insulated Pipe – Cold Services (including chilled water piping):
   a. 5 Inch and Smaller Pipes:
      i. Adjustable steel clevis with galvanized sheet metal shield.
   b. 6 Inch and Larger Pipes:
      i. Pipe roll with sockets with pipe covering protection saddle.
      ii. Adjustable steel yoke pipe roll with pipe covering protection.

E. Pipe Anchors:
1. Provide a complete system of accessories to transmit thermal expansion forces to the building structure for redirection to the piping expansion compensation system. Anchors shall consist of structural attachments, framing members for translating forces to and from the building structure and plates welded to the appropriate piping sections.
2. Structural attachments shall be as appropriate for the point of connection intended. Verify anchor connection points with Project Structural Engineer prior to fabrication.
3. Framing members shall be sized to accept the forces associated with the Contractor's proposed piping system arrangement with a minimum factor of safety of 3.0.
4. Framing point of attachment to the appropriate piping section shall be of a minimum thickness of 1/4" and shall increase by 1/16" in thickness for each two-pipe size increases above three inches in diameter (3"Φ). Framing point of attachment to the appropriate piping section shall be of a minimum length of 16" and shall increase by 2" in length for each two pipe size increases above three inches in diameter (3" Φ).
5. Welds to connect framing point of attachment to the appropriate piping section shall be full penetration fillet welds parallel to the central axis of the piping. All welding processes, including but not limited to procedures and welding operator qualifications, shall be in strict accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code (edition, including any addenda, in effect at the time of the contract execution).

F. Pipe Clamps:
1. Provide pipe clamps with weld-less eye nuts to allow flexibility in the hanger assembly to adjust for horizontal movement. Provide double bolted pipe clamps for insulated lines.

G. Multiple or Trapeze Hangers:
1. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A570 Gr. 33 structural steel channel, 1⅝ x 1⅝" minimum, or stronger.
2. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe.

3. For pipes subjected to axial movement:
   a. Strut mounted roller support. Use pipe protection shield or saddles on insulated lines.
   b. Strut mounted pipe guide.

H. Wall Supports:
1. Pipes 4 Inches and Smaller:
   a. Carbon steel hook.
   b. Carbon steel J-hanger.
2. Pipes Larger than 4 Inch:
   a. Welded strut bracket and pipe straps.
   b. Welded steel brackets, with roller chair or adjustable steel yoke pipe roll. Use pipe protection shield or saddles on insulated lines.

I. Floor Supports:
1. In mechanical spaces where weight of piping or other apparatus makes it impractical to support same suspended only from structure above, flanged pipe standards shall be installed to support the weight of the piping, valves and fittings. Main passageways and access space must not be obstructed.
2. Hot piping under 6 inch and all cold piping:
   a. Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Pipe saddle shall be screwed or welded to appropriate base stand.
3. Hot piping 6 inches and larger:
   a. Adjustable roller stand with base plate.
   b. Adjustable roller support and steel support sized for elevation.

J. Vertical Supports:
1. Steel riser clamp sized to fit outside diameter of pipe.

K. Copper Tubing Supports:
1. Hangers shall be sized to fit copper tubing outside diameters.
   a. Adjustable steel swivel ring (band type) hanger.
   b. Malleable iron ring hanger, or hinged ring hanger.
   c. Malleable iron split-ring hanger with eye socket.
   d. Adjustable steel clevis hanger.
2. For supporting vertical runs use epoxy painted or plastic coated riser clamps.
3. For supporting copper tube to strut use epoxy painted pipe straps sized for copper tubing, or plastic inserted vibration isolation clamps.

   Note: Copper plating of hangers is for purposes of identification only. This superficial coating shall not be designed to provide significant protection in corrosive areas.

L. Plastic Pipe Supports:
1. V-bottom clevis hanger with galvanized 18 gauge continuous support channel.

M. Supplementary Structural Supports:
1. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by B-Line or Uni-Strut.
2. Channels shall be roll formed, 12 gauge, ASTM A570 Grade 33 steel, 1⅝" x 1⅝" or greater to meet loading conditions. Submit designs for pipe tunnels and pipe galleries to Engineer for approval.
3. Clamps and fittings shall be specifically designed and listed for use with the strut system.

N. Upper Attachments:
1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
   a. C-Clamps shall have locknuts and cup point set screws. Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes. Refer to manufacturer's recommendations for setscrew torque. Retaining straps shall be used to maintain the position on the beam where required.
   b. Center loaded beam clamps shall be used where specified. Steel clamps, malleable iron or forged steel beam clamps with cross bolt shall be suitable to fit beams.
2. Concrete Inserts:
   a. Cast in place spot concrete inserts shall be used where applicable, either steel or malleable iron body. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes.
      i. Arrange pipe hangers, and auxiliary framing if required, to limit the maximum pipe load, with pipes fully insulated and filled with water, to not exceed 1500 pounds on any one slab insert.
      ii. Inserts shall be spaced not closer than 4 feet o.c. in either direction. Where pipe inserts are closer together than 4 feet o.c. notify the Architect for review.
   b. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A570 Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a minimum load rating of 2,000 lbs/ft. in concrete. Select channel nuts suitable for strut and rod sizes.
   c. Provide inserts for placement in form-work before concrete is poured.
   d. Provide inserts for suspending hangers from reinforced concrete slabs and sizes of reinforced concrete beams.
   e. Where concrete slabs form finished ceilings, provide inserts to be flush with slab surface.
   f. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

O. Vibration Isolation and Supports:
1. Refer to Section "Vibration Isolation and Seismic Restraints" for vibration isolation requirements.
2. All horizontal runs of pipe in all mechanical equipment rooms, and for a distance of fifty (50) equivalent pipe diameters beyond the respective mechanical equipment rooms, shall be isolated from building structure by means of units designed for insertion of rids. Selection of correct isolators for each application shall be made by the vibration isolation manufacturer subject to approval of the Architect.

P. Accessories:
1. Hanger rods shall be threaded both ends, or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain or perforated straps shall be allowed.
2. Shields shall be 180° galvanized sheet metal, 12" minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe.
3. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum

thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inches shall have a center support rib.

Q. Finishes:

1. Hangers not in direct contact with copper pipe shall be zinc plated in accordance with ASTM B633, SC3 or have an electro-deposited epoxy finish.
2. Strut channels shall be pre-galvanized in accordance with ASTM A653 G90 or Strut channels shall be electro-deposited epoxy finish.
3. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123.
4. Hangers and strut located in corrosive areas shall be Type 316 stainless steel with matching stainless steel hardware.
5. Hangers and clamps for support of bare copper piping shall be painted with electro deposited copper colored epoxy.

R. Support Spacing:

1. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE	ROD DIAMETERS	MAX. SPACING
1/2" - 1½"	3/8"	7'0'
1½"	3/8"	9'0"
2"	3/8"	10'0"
2½"	1/2"	11'0"
3"	1/2"	12'0"
4"	5/8"	14'0"

2. Horizontal copper tubing shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL TUBE SIZE	ROD DIAMETERS	MAX. SPACING
1/2" – 3/4"	3/8"	5'0'
1"	3/8"	6'0"
1¼"	3/8"	7'0"
1½"	3/8"	8'0"
2"	3/8"	9'0"
2½"	1/2"	10'0"
3"	1/2"	11'0"
4"	1/2"	12'0"

S. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape. Galvanized felt isolators sized for copper tubing may also be used.

T. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.

U. Place a hanger within 12 inches of each horizontal elbow.

V. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every other floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

W. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified herein above. Trapeze hangers shall be spaced according

to the smallest pipe size, or install intermediate supports according to schedule herein above.

X. Do not support piping from other pipes, ductwork or other equipment which is not building structure.

2.30 PIPING MATERIALS

A. All piping materials installed under this section shall be new and shall consist of the following materials of construction:

System of Section	Piping Class
Hot Water Supply and Returns	2
Chilled Water Supply and Returns	2
Make-Up Water	20
Relief Valve and Vent Lines	2
Drain Lines	2
Cooling Coil and Louver Condensate Pan Drains	20
Chemical Feed	9
Refrigerant Piping	12

Note: Class 20 piping may be used in lieu of Class 2 piping for two-inch (2”) and smaller diameter piping for hot water, chilled water and any size drain line.

B. Class 2 Piping System

	2 Inches and Smaller	2-1/2 Inches and Larger
Construction	Screwed construction with screwed or flanged connections to equipment.	Butt-welded construction with flanged connections to valves and equipment.
Piping	Carbon steel, Schedule 40, ANSI B36.10, ASTM A120.	Carbon steel, Schedule 40 to 8"; Schedule 30 for 10" to 18"' Schedule 20 for 20" to 24"; ANSI B36.10, ASTM A53, Grade A or B (except that all steam and hydronic heating systems piping shall be Schedule 40).
Fittings	Malleable iron, 150 lb. class screwed ends, ANSI B16.3, ASTM A197.	Carbon steel, schedule to match piping, butt-weld ends, ANSI B16.9, ASTM A234, Grade WPA.
Couplings	Same as "Fittings" above.	
Unions	Malleable iron, 300 lb. class, screwed ends, ANSI bronze-to-bronze type, ANSI B16.5, ASTM A181, Grade 1.	Forged steel, 150 lb. ANSI Standard weld-neck type flange, ANSI B16.5, ASTM A181, Grade 1.
Flanges	Forged steel, 150 lb. ANSI	Same as "Unions" above.

standard screw-on type, ANSI B16.5, ASTM A181, Grade 1.

C. Class 9 Piping System

	2 Inches and Smaller	2-1/2 Inches and Larger
Construction	Screwed construction with screwed or flanged connections to equipment.	Butt-welded construction with flanged connections to valves and equipment.
Piping	Stainless steel, Schedule 40, ANSI B36.26, ASTM A312, Grade TP 304L.	Stainless steel, Schedule 40, ANSI B36.26, ASTM A312, Grade 304L.
Fittings	Forged stainless steel, 2000 lb. ANSI standard, screwed type, ANSI B16.11, ASTM A182, Grade F304.	Forged stainless steel, Schedule 40, butt-welded ends, ANSI B16.9, ASTM A182, Type 304L.
Couplings	Same as "Fittings" above.	
Unions	Forged stainless steel, 2000 lb. ANSI standard, socket-welded stainless steel seats, ASTM A182, Grade F304.	Forged stainless steel, 300 lb. ANSI standard, weld-neck type flange, ASTM A182, Grade F304.
Flanges	Forged stainless steel, 300 lb. ANSI standard, socket-welded type, ASTM A182, Grade F304.	Same as "Unions" above.

D. Class 12 Piping System

	All Pipe Sizes
Construction	Hard brazed joints.
Piping	Copper tubing, Type ACR, hard drawn; cleaned, dehydrated and capped for refrigeration service, ANSI B70.1, ASTM A280.
	All Pipe Sizes
Fittings	Wrought copper, brazed joint type, ANSI B16.22.
Couplings	Same as "Fittings" above.
Brazing Alloy	East Flo, Sil Fos, Phos. Co. minimum 1100 ºF melting temperature ASTM B260.

E. Class 20 Piping System

	2 Inches and Smaller	2-1/2 Inches to 8 Inches
Construction	Soldered joint construction with threaded adaptors.	Screwed construction with flanged connections to valves and equipment.
Piping	Copper, Type L, hard drawn, ANSI H23.1, ASTM B88.	Carbon steel (galvanized), Schedule 40, ANSI B36.20, ASTM A120.
Fittings	Cast bronze or wrought copper, solder joint type, ANSI B16.19 or B16.22.	Cast iron (galvanized), 125 lb. class, screwed ends, ANSI B16.3, ASTM A197.
Couplings	Same as "Fittings" above.	Same as "Fittings" above.
Unions	Wrought copper, solder joint type, ANSI B16.19 or B16.22.	Malleable iron fittings (galvanized), 125 lb. ANSI standard, screw-on type, ANSI B16.1.

F. Flange Bolts and Nuts
1. CI to CI, CI to CS, CI to CB and CB to CB.
2. Bolts: ANSI, B181, ASTM A307, Grade B, square head, coarse threaded series, Class 2B fit.
   a. CS to CS
   b. Stud Bolts: ASTM A193, Grade B7, Class 2A fit.
   c. Nuts: ANSI B18.2.2, ASTM A194, Grade B7, heavy hexagonal series, semi-finished, Class 2B fit.

G. Gaskets: For all pipe classes except as note:
1. Gaskets: Flat ring 1/16-inch thick rubber, Garlock Style 3100 graphite or equal. ADA rated for service.
2. For make-up water service and cooling tower water.
   a. Gaskets: Full face 1/16-inch thick rubber, Garlock 22 or equal.
   b. For fuel oil service:
      i. Gaskets - Garlock 2021.

H. Solder for Class 20 Piping: 95-5 tin antimony or 95.5 lead-tin conforming to ASTM B32, allow Grade 5A.

2.31 REFRIGERANT PIPING AND SPECIALTIES

A. Summary:
1. Extent of refrigeration piping, fittings, valves and accessories is indicated (on the drawings and by the requirements of this section and section 15B.03 “General Requirements – Mechanical”).
   a. Refrigeration piping is specified on a performance basis and the Contractor is responsible for the design and preparation of shop drawings covering all refrigeration piping work.
2. Related Sections: Refer to other Division 15 sections for the following:
   a. Mechanical Insulation

B. Quality Assurance:
   1. Codes and Standards: Provide refrigeration piping conforming to the requirements of the following:
      a. Air Conditioning and Refrigeration Institute (ARI).
      b. American National Standards Institute (ANSI).
      c. American Society for Testing and Materials (ASTM).
      d. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
      e. Manufacturer's Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

C. Submittal:
   1. Refer to Section 15B.02, "Submittals" for basic information relating to submittal requirements.
   2. Product Data: Submit manufacturer's technical product data on the following:
      a. Refrigerant Valves
      b. Refrigerant Specialties

D. Refrigerant Piping:
   1. Refrigerant Piping: Dimensions and material requirements for pipe, pipe fittings and components shall conform to ASHRAE 15 and ANSI B31.5 and shall be compatible with fluids used and capable of withstanding the pressures and temperatures of the service.
      a. Tubing used for refrigerant service shall be cleaned, sealed, capped, or plugged prior to shipment from the manufacturer's plant.

E. Valves and Accessories:
   1. Valves: Provide valves designed, manufactured and tested specifically for refrigerant service.
      a. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Threaded ends of valves shall conform to ANSI B2.1.

F. Execution – General:
   1. Installation: Install piping components to ensure proper and efficient operation of the equipment and controls and in accordance with manufacturer's printed instructions.
      a. Provide proper supports for the mounting of vibration isolators, stands, guides, anchors, clamps and brackets.
      b. Provide piping connected to equipment with vibration isolators with flexible connections which shall conform to vibration and sound isolation requirements for the system.
      c. Conform to ASHRAE 15 and ANSI B31.5.

2.32 PRESSURE GAUGES

A. Pressure gauges shall be of sizes, types and capacities specified herein and located as indicated on the drawings. Equipment shall be as manufactured by Ashcroft, Trerice or Manning, Maxwell, Maxwell and Moore.

B. Except as otherwise indicated, all gauges shall be 4½ inch diameter stainless steel case and ring phosphor bronze bourbon type, 1 percent full scale accuracy and bottom connection. Gauges for panel mounting shall have stainless steel flush mounting ring and back connection. Gauges for fluid handling service shall have isolating cock and also fitting with pulsation dampeners and red setpoint indicators at pump inlets and outlets. Gauges for steam service shall have coil syphon and isolating cock. All cocks

shall be rated at 150 WSP except on HP steam service, 250 WSP.

C. Gauge range shall be as follows:
   1. Chilled Water 0-100 PSIG
   2. Hot Water 0-100 PSIG

   Note: Mount all gauges so as to be read from floor. Provide two (2) spare gauges for each range indicated.

2.33 PUMPS

A. Pumps shall be of sizes, types, capacities and arrangements indicated on Drawings. Equipment shall be manufactured by Taco, Bell and Gossett, Grundfos or Armstrong.

B. Equipment shall be complete shop-assembled packages with pump, motor drive couplings, pump base assemblies and accessories. All equipment shall be shop primed and finish painted. All pumps shall be field checked for alignment and corrected prior to start-up. This Contractor shall be responsible for insuring compatibility of chemical treatment program with pump seals used. Pumps shall not overload their drivers along any point of their entire operating curves. All pumps shall have suction and discharge flanges drilled and tapped for pressure gauge installation. All pumps shall be capable of operating at water temperatures from 35 degrees F. to 250 degrees F. All pumps shall have drip bases. Drip bases to be piped to floor drain and shaft seal drains shall be piped to drip base by this Contractor.

C. Inline Suction Pumps: Pumps shall be base mounted, single stage, double suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.
   1. Shall be rigidly coupled pipe-mounted types. Pump features shall include bronze impeller, alloy steel shaft, 100,000 hour ball bearings, cupro-nickel steel shaft sleeves, stuffing boxes, mechanical seals, 250 PSI test vertically split casings, flanged suction and discharge connections, rigid pump/driver coupling, coupling guard, motor driver and rigid pump-driver mounting baseplate and frame.
   2. Pump volute shall be Class 30 cast iron, suitable for 175 PSI working pressure, with integrally-cast pedestal support feet. The impeller shall be cast bronze enclosed, double suction type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.
   3. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal. Seals shall be capable of serviceability without disconnecting the pump from its piping.
   4. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
   5. Pump bearing bracket shall have oil lubricated bronze journal and thrust openings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.
   6. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation prior to start-up.
   7. Each pump shall be factory tested per Hydraulic Institute Standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

D. End Suction Pumps: Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without

disturbing piping connections.

1. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.
2. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.
3. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
4. Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base.
5. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation.
6. Each pump shall be factory tested per Hydraulic Institute Standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
7. Shall be flexible coupled base-mounted types. Pump features shall include bronze impeller, alloy steel shaft, 100,000 hour ball bearings, cupro-nickel steel shaft sleeves, stuffing boxes, mechanical seals, 250 PSI test vertically split casings, flanged suction and discharge connections, flexible pump/driver coupling, coupling guard, motor driver and rigid pump-driver mounting baseplate and frame.

E. Shop Drawings shall include complete dimension drawings of all equipment furnished, together with individual pump curves, and electric data.

2.34 RADIANT HEATING PANELS

A. Radiant heating panels shall be of the types, sizes and capacities indicated on the Drawings. Radiant heating panels shall be as manufactured by Sunel, Aerotech or Airtex.

B. Radiant heating panels shall be constructed of extruded aluminum with a approximate overall thickness of 0.115 inches. The panel shall consist of an assembly of five inch (5") strips to the width indicated on the drawings. The strips shall have a 0.495 inside diameter copper tube expanded within a circular cavity in the extrusion for an intimate 360º contact of copper tube to aluminum extrusion under all operating temperature conditions. Ends of tubes shall be swagged to 0.503 inches inside diameter for proper soldering fit of 3/8-inch Type"L" soft copper tubing. Panel size shall be as indicated on the drawings. Panel size shall be as indicated on the drawings. Panel face configuration and color shall be as selected by the Architect. The panel finish shall be two (2) coats of baked enamel painted after assembly.

C. Radiant heating panels shall be installed by a qualified Contractor.
   1. Ceiling panel contractor qualifications:
      a. Be regularly and continuously in the business of installing radiant ceilings for a period of no less than five (5) ears prior to the bid date of this project.

b. Have installed no less than twenty-five (25) radiant panel installations.
c. Be certified by the manufacturer, in writing, as the authorized installing contactor.
d. Provide a list of installations as per Paragraph 1.b above.

2. Testing
   a. The Radiant Ceiling Panel Subcontractor shall perform hydrostatic text on all circuits of radiant panels. The test shall assure that here are no leaks in the system up to 150 psi.
3. Others
   a. All supply and return piping to within twenty-four inches (24") of the radiant circuits and valves, strainers, unions, air vents, gauges and the like shall be furnished and installed by the Mechanical Contractor. Final connections shall be made by the Mechanical Contractor.
4. Installation
   a. Panels shall be installed in openings provided by others. Panels shall be trimmed and notched where required, to fit neatly at walls, columns and other projections.
   b. All interconnections shall be made by the radiant panel installed. Interconnections shall consist of 6'0" "loops".
   c. Insulation as specified shall be installed over all active radiant panels.
   d. Specified clips to hold down panels and wire hangers (for panels 24" wide or wider) shall be installed.
   e. All panels shall be left free of finger marks or other foreign matter.

2.35 REGISTERS, GRILLES AND DIFFUSERS

A. Registers, grilles and diffusers shall be of model, size and capacity and furnished as scheduled on the drawings. Equipment shall be as manufactured by Titus, Tuttle & Bailey, Krueger or Metal-Aire and shall be supplied with white baked enamel finish except where noted otherwise.

B. All supply registers shall be furnished with individually adjustable face louvers. Registers and grilles shall be supplied with white baked enamel finish except where noted otherwise.

C. Diffusers, registers and grilles for installation in walls or plastered ceilings shall be provided with sponge rubber frame gaskets and Phillips head screws for attachment of device frame to building construction.

D. The diffuser shall be provided with a removable core permitting easy access to core sections. Diffuser neck shall extend no less than 1 inch above the core to accommodate an internal duct connection to prevent leakage to ceiling space. Diffusers shall be assembled in patterns which provide one, two, three or four-way air discharge with each side delivering a quantity of air proportional to the area served.

E. When indicated by manufacturer's model number on the equipment schedule, the ceiling diffusers shall be of the restricted multi-orifice jet induction and air mixing type consisting of louver sections with built-in diffusing vanes. The vanes shall be arranged to discharge air from adjacent louvers at an angle of 45 degrees in opposite directions to ensure rapid mixing of primary and room air. Each individual diffusing vane shall be welded in place and mechanically fastened to adjacent louver sections to make a rigid unit. The vanes shall extend to the discharge edges of the louvers. Where louver sections join core frame, the louver ends shall be welded to core frame. The leaving edge of each louver shall be hemmed and the louver ends shall be rounded and hemmed before welding the core frames.

F. All duct connections to registers, grilles and diffusers shall have all interior surfaces

with the line of sight or within 4 feet of the opening painted with dull black paint.

2.36 ROOFTOP AIR HANDLING UNITS

A. Furnish and install air handling units as manufactured by Annexair, Hakkon, Seasons Four or approved equal. The unit manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum five years documented experience, who issues complete catalog data on total product and has a minimum of ten installations using the scheduled product model.

B. The operating range shall be between 115°F and -20°F as standard for all units. Performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with UL 1995/CAN/CSAINo. 236-M90.

C. Unit shall comprise of, but not limited to, AHU sections shown on drawings and the following list:
1. Double wall cabinet.
2. Hot water heating coil section
3. CW cooling coil section
4. Pre Filter section
5. Final Filter section.
6. Supply air fan section.
7. Intake and mixing section with dampers and louvers or hoods.
8. Fan motors compatible with variable frequency drives
9. Outside air intake plenum
10. Return/relief air fan section.

D. Design and Construction Features:
1. Housing:
   a. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one piece as shown on drawings. The frame shall consist of robust injection molded corners and extruded thermally broken aluminum profiles; welded together for reinforcement. Base structure shall be fully welded with formed heavy gauge galvanized steel and have integral lifting lugs which can be removed once the unit is installed. “Thermo-composite” panels shall be mechanically fastened to the base structure. Unit casing must be guaranteed to have no exterior condensation at interior AHU temperatures down to 43F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb.
   b. All roof, floor and wall panels shall be made from “thermo-composite” panels, with an aluminum interior and exterior liner. All panels and access doors shall be 2” thick double wall construction with R14 foam insulation, and Greenguard certified®. The panels shall be capable of withstanding air pressure up to 10” w.c with 1/16” panel deflection. Panels shall be fastened from the interior and gasketed along the frame to reduce thermal transmission. Fixed panels shall be removable without affecting the housing integrity.
      (1) Alternate construction: All roof and wall panels shall be made from aluminum, minimum. 12 Ga Aluminum Exterior wall and 22 Ga Steel Metal Liner. All panels and access doors

shall be double wall construction with (R-12) two-inch thick, minimum 3.0 pcf polyisocyanurate foam insulation. All casing panels and frame must be provided with true thermal break. Base shall be fully welded with formed heavy-gauge galvanized steel with removable integral lifting lugs. .125" Aluminum Checkerplate Floor – Fully Welded, capable of holding 1.5" of water. 6" channel base rail. Floor shall be aluminum, minimum .063", mechanically fastened to the base with minimum (R-12) two-inch thick polyisocyanurate foam insulation and 22ga Galvanized Steel metal under liner.

c. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than L/1150 at 10'' and withstand air pressures up to 8" w.c. Leakage to be guaranteed at no more than 1% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater. All casing walls shall be of panel construction, including the fan discharge walls, mixing section walls.

d. Access doors shall be provided to all major components to facilitate quick and easy access. Access doors are to be provided with open guard door locks to lock the door in the open position for safe access in windy conditions. All access door(s) shall have Allegis type latches and nylon type hinges designed to open 180 degrees. Doors shall open against air pressure as indicated on drawings. Removable panels provided for equipment pull out for coil(s) and heat exchanger(s) shall have key tooled threaded insert fasteners, and have at least one fixed handle on the outside. Access doors shall be sealed with a full "U-Shaped" gasket for superior air tightness along the door edge. Bulb type gaskets shall not be acceptable since they do not return to their original form once compressed.

e. The airflow separation wall between the outside air intake and exhaust air outlet shall be one inch double wall "thermo-composite" panels insulated with minimum R7 foam insulation and Greenguard certified®.)

f. All roof and side wall seams shall be positively sealed to prevent water and air leakage.

g. Outdoor units shall have a rain gutter above each access door and a watertight roof shall be provided with a white TPO UV-reflective membrane. The entire exterior will be finished with (2) two coats of acrylic urethane enamel, manufacturer standard color. Paint shall pass ASTM B117 3000-hour salt fog resistance test and ASTM D4585 3000-hour moisture condensation resistance test. Floor openings shall be covered with 1" fiberglass safety walk-on gratings.

h. Air handler unit casing shall be provided with a lifetime warranty against corrosion resistance under normal use.

2. Supply and Return Fans:

a. The fans shall be carefully positioned and installed at an optimal distance to respect uniform airflow across the coil(s).

b. Plug Fans: Fans shall be direct drive radial centrifugal fans with free running impeller. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating. To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less

than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from galvanized sheet steel. Fans shall have maintenance free ball bearings, closed on both sides, sealed for life. Fans shall be completely certified as per ISO 5801 and to AMCA standards. Fans will require to be operated by a Variable speed drive. Plug fan shall come equipped with guard grills for the air intake side.

c. The unit manufacturer shall provide flexible connection between fan and fan wall. Flex connection material shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.

d. The fan and motor shall be factory-mounted on a welded structural steel spring type vibration base. The base shall be mounted on stable / adjustable, seismically restrained (seismic zone 2) isolators with 2" maximum deflection rating. Spring efficiency shall not be less than 98%.

e. The unit shall be delivered with factory installed airflow measuring system. The airflow measuring system, consisting of a piezometer ring and transducer, shall be installed on the fans. The package consists of an inlet port on the fan inlet cone connected with flexible tubing to the transducer.

3. Fan Motors:

a. The fan motors shall meet NEMA standard dimensions and comply with the Energy policy Act of 1997. Motors shall have high efficiencies with low noise and vibration output. Motors shall be certified and built in accordance to ISO 9001 quality control system.

b. Motors shall be 1750 or 3600 RPM, 460V/3ph/60 Hz as scheduled and as per the following:

i. Motor shall be premium efficient, ODP enclosure, with cast iron housing and end bells. Motors shall be furnished with efficiencies equal to or greater than those specified in the Energy Policy Act of 1992 (EPACT).

ii. Motors shall be inverter duty rated.

iii. Motor shall be of HP as listed on schedule and be selected for a minimum of 10% over calculated BHP. The motor service factor shall be a minimum of 1.15.

iv. Motor shall be designed for continuous duty operation, NEMA Design B with Class F insulation.

v. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.

vi. Motor bearing life shall be L-10 200,000 hours.

vii. Provide stainless steel nameplate indicating the following:

a) NEMA efficiency index nominal efficient (MB1-12.53BO).

b) AFBMA bearing numbers.

c) Lubrication instructions.

d) A shaft grounding brush kit will be provided to prevent electrical damage to motor bearings by safely channeling harmful shaft currents to ground.

viii. Acceptable motor manufacturers: Reliance, General Electric, Baldor

4. Fan Airflow Balancing:
   a. Provide the EZ Balancer fan air flow measurement and control system with fan inlet bell air flow measuring taps, electronic controller with digital display of cfm for each fan and transducer. The system must allow setting of required airflow of the fans without the need to adjust VFD settings by simply using up/down keypad buttons. One (1) EZ Balancer is required for up to two (2) airflows even if multiple fans are used and can be applied for constant and variable airflow applications with a 0-10Vdc signal.

5. OA Airflow Balancing and Monitoring Package:
   a. Economizer: The economizer segment shall be furnished with factory installed integral air flow monitor/damper.
      i. The integral airflow monitor/damper shall be a Ruskin AMS-60.
      ii. The integral airflow monitor/damper shall be tested to AMCA Standard 611-95.

6. Variable Frequency Drive (VFD)
   a. The VFD shall use Insulated Gate Bipolar Transistor (IGBT) technology to convert three phase input power to coded Pulse Width Modulation (PWM) output. The VFD shall be equipped with easy access function for the most frequently used parameters in HVAC applications. The VFD keypad shall have door mounted status indicators. The VFD shall have monitoring functions to monitor VFD during motor operation. The VFD shall have a carrier frequency that is able to switch the IGBT at 15 kHz. The power terminal strip shall have at least (8) eight digital programmable input terminals. The VFD shall also have programmable output terminals. The VFD shall have 4-20mA analog output terminals that are fully programmable. The VFD shall have the ability to retry automatically after a fault. In the event of a momentary power failure the VFD shall read the inverter speed and direction of a coasting motor and shall restart the motor smoothly. The drive shall have electronic thermal protection settings to protect the motor. The VFD shall have PID function for constant flow applications. The VFD manufacturer shall provide at no charge phone support on VFD. In addition to that, every VFD smaller than 20 hp shall be available in either extender box or integrated enclosure configuration. VFD larger than 20 hp shall be mounted in an integrated enclosure only including the power unit, contactors, relays, and all specified accessories. VFD's shall not have "by-pass" for direct driven fans since they may damage the unit if the motor rpm is higher than the actual rpm required.

7. Filters
   a. Pre-Filters (Maxi Pleat 2" MERV 8 (25-30%))
      i. Filters shall be factory installed upstream of the heat exchanger and coils, in both airstreams. The air filters shall be Filtration Lab's Maxi-60 MERV 8. Each filter consist of 100% synthetic media, expanded metal on the downstream and enclosing with high wet-strength beverage board with diagonal support bonded on air entering and air exiting side of each pleat. MERV 7 model 415 FILTERS, u.l. class 2 are rated as per ashrae test 52.2.1999 at 55% efficiency initial (based on Minimum Average

Efficiency) at 3-10 microns. The model 415 could be operated at 500 fpm, surface area 17.6 FT2 of media based on 24 x 24 x 2 initial static pressure at 0.28" final will be 1". Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.

b. Final (Mega-Pak 4" MERV 13 (85%)
   i. Filters shall be factory installed where shown on the drawings. The air filters shall be Filtration Lab's Mega-Pak MERV 13. Each filter shall consist of 100% synthetic media, expanded metal on the downstream and enclosing frame shall be constructed of a rigid galvanized steel to provide a durable housing for the filter pack. The filter shall have a steel reinforced diagonal support braces affixed on both sides of the filter and it shall have plastic fingers for affixed on both sides of the media pack to control spacing as well to prevent the pleat rows from collapsing one upon the other.

c. Filter Gauge
   i. Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with stainless steel static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank. The filter gauge shall be mounted on the unit exterior.

8. Control and Smoke Dampers:
   a. Dampers shall be installed where shown on the drawings. Dampers shall be low leak type with rubber edges, opposed or parallel blades, and constructed from extruded aluminum. Galvanized dampers will not be acceptable.

   b. Dampers shall be installed in the following compartments with linkage rod for actuators:
      i. Outdoor air intake.
      ii. Return/Recirculation air damper
      iii. Relief outlet

   c. Actuators shall be 24V factory installed; modulating type. All actuators shall have spring return mechanism and auxiliary switches.

   d. Dampers will be installed in the failed close position unless otherwise noted. Smoke dampers meeting the following specifications shall be furnished and factory installed where shown on the Bid Drawings.

   e. Smoke dampers shall be furnished, factory mounted and wired by the AHU manufacturer on all supply and return air duct connections 15,000 cfm and larger. Dampers shall be Greenheck SMD-43, Ruskin SD-50 or approved equal.

      i. Damper shall be selected for opposed blade action.
      ii. Smoke dampers shall meet the requirements of NFPA 90A, 92A, 92B, 101 and further shall be tested, rated and labeled in accordance with the latest edition of UL Standard 555S. Smoke dampers shall be of low leakage design qualified to UL 555S Leakage Class III. Smoke dampers shall be FM approved and AMCA tested.

iii. Dampers shall be UL listed, testing to be capable of withstanding 4" W.G. differential pressure at 2,000 FPM approach velocity.
iv. Each damper/actuator combination shall have a UL555S elevated temperature rating of 250 degrees F. shall be rated to operate at maximum design air flow at its installed location.
v. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall electric and be furnished with two end switches to annunciate full open and full closed position of smoke damper.
vi. Damper frames shall be made of galvanized steel or extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and flexible synthetic blade edge seals to keep leakage to a minimum.
vii. Bearings shall be stainless steel sleeve type rotating in extruded holes in the damper frame.
viii. Damper must be rated for mounting vertically (with blades running horizontal) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper.
ix. Each damper section shall not exceed 60" x 60". Provide linkage between sections.
x. Damper linkage to be concealed in frame channel outside of the airstream. Provide a minimum of one electric damper actuator per 25 S.F. maximum damper area.

9. Vertical Tube Integral Face & Bypass (VIFB) Hot Water Coils (See Details)
a. Coil shall be installed as shown on the drawings. Arrangement, capacity etc, shall be as shown on the coil schedule (and/or drawings). Air pressure drop scheduled shall not be exceeded.
b. The coil ratings shall be certified in accordance with ARI 410 standards.
c. The coil shall consist of an integral series of finned heating elements and element by-pass with interlocked dampers. The coil shall be capable of maintaining constant discharge air temperatures regardless of variations in the entering air temperature, with full water flow in the coil at all times.
d. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 PSIG working pressure and up 400 deg F.
e. The elements shall consist of .008" thick patterned aluminum plate fins applied to 5/8" OD .035" thick seamless copper tubes.
f. The finned elements shall be secured to a carbon steel header by means of a silver brazed joint.
g. The supply/return header(s) shall be enclosed within the coil casing at the base of the unit and not exposed to the air stream.
h. Elements shall be arranged in a vertical position. The use of expansion joints shall not be required.
i. The tubes shall be connected to the headers in a straight thru manner (no 90 degree bends).
j. Casings shall be minimum 12 GA galvanized steel, braced and flanged (punched if necessary for duct or wall mounting). End casings shall have smooth, embossed tube holes to avoid abrasion during expansion and contraction.
k. Dampers shall be wrap around "clamshell" design. Dampers shall be minimum 16 GA galvanized steel.

l. Interconnecting bars shall be stainless steel. Operator lever arms shall be welded to a common shaft for permanent alignment with pivots on bronze oilite bearings. The operator shall connect to the damper linkage via threaded ball joint rod ends.

m. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.

10. Standard Hot Water Heating Coils (See Details):
    a. Hot water coils shall have 5/8" O.D., 0.035" thick copper tubes with helically wound 0.008" thick aluminum fins by Aerofin, Heatcraft or Marlo.
        i. Casing shall be 16-gauge galvanized steel.
        ii. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure.
        iii. Coil fins shall be flat or rippled fin design, .0075" aluminum. Air pressure drop scheduled shall not be exceeded.
    b. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
        i. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
        ii. Coil casing shall have removable panel on exterior side.
    c. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.
    d. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

11. Chilled Water Cooling Coils
    a. Chilled water coils shall have 5/8" O.D., 0.035" thick copper tubes with 0.008" thick aluminum plate fins by Aerofin, Heatcraft or Marlo.
    b. Coils shall be selected for use with fresh water.
    c. Casing shall be 16-gauge stainless steel for cooling coils.
    d. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
    e. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
    f. Coil connections shall be same end. AHU manufacturer shall clearly label each pipe connection with a supply or return designation.
    g. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
        i. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
        ii. Coil casing shall have removable panel on exterior side.

iii. Drain pan shall be provided for cooling coils. Cooling coils shall sit on stainless steel tubular support rails, which shall stand a minimum of (2) two inches above the highest point of the floor drain pan. Stacked coils shall be provided for larger airflows and intermediate drain pans shall be provided for each coil bank. Drain pans shall be stainless steel with stainless steel drain connections on one side only. Drain pans shall be triple sloped IAQ type. All coils shall be certified in accordance with ARI standard 410.

i. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.

j. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

k. All coils shall be certified in accordance with ARI standard 410.

12. Power & Safety Control:

a. The power and control center shall be integral to the unit housing and rated NEMA 4X. All wiring shall be accomplished by the manufacturer and must be tested under a high pot test. Under no circumstances shall any wiring or parts be field installed. Panels that are externally mounted to the unit shall not be accepted, regardless of the NEMA rating they may have. A separate access door shall be provided with an approved locking device. All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with motor starters / VFDs, fuses, cascading overloads (without VFD's or 2 motors on same VFD), relays, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for on/off servicing. Any power or control wiring that is field installed shall not be accepted under any circumstances. If units show up at the job site without wiring by the manufacturer, the contractor will have to send back units to the manufacturer at the contractors' expense to get them factory wired and re-tested.

13. Service Power & Lighting:

a. GFI, lights and switches shall be factory installed and wired to a non-fused safety disconnect switch shall be factory installed for on/off servicing. A separate power connection 120/1 will be required (powered by others).

14. Controls:

a. All controls to be by ATC contractor.

15. Roof Curb:

a. A seismically rated insulated, pre-fabricated roof curb shall be provided and shipped knocked down. The roof curb will be made of 16-gauge galvanized steel with 4" flanges, maximum 24" high with a factory installed 2" x 3" wood nailer strip.

b. The mechanical contractor shall be furnish and install all shims and or pressure treated blocking to insure a level curb.

16. Warranty:

a. Unit manufacturer warrants each product to be free from defects in material and workmanship under normal and proper use, and will within

twelve (12) months from date of start-up and not exceed eighteen (18) months from shipment, repair or replace any part which, when returned to our factory transportation charges prepaid, and upon inspection by Annexair, proves to be defective. This warranty does not include any labor or service charges that occur under this warranty. The installing contractor must be responsible for warranty service and maintenance after the equipment is placed into operation.

17. Equipment Start-up:
    a. The equipment start-up and operational check out is the responsibility of the mechanical contractor who purchases the equipment and associated personnel responsible for its operation. Manufacturer must provide a factory-trained technician who will provide Start-Up Supervision. A written request for Start-Up Supervision must be received a minimum of 2 weeks before expected start-up date in order to schedule it. The mechanical contractor must supply personnel, tools, gauges and instruments as required to run the equipment. The personnel responsible for the operation of the equipment must be present for the start-up.

18. The minimum outdoor air and economizer outdoor air hoods shall be designed with a 4" extruded aluminum louver,bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 45 degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.03 oz/ft2 water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.05" wc at a maximum 450 fpm. 2. The exhaust air outlet louvers shall be 2" extruded aluminum, with nonrestricting blade design and bird screen."

2.37 SHEET METAL WORK

A. General: Ductwork systems shall be fabricated and installed in accordance with recommendations contained in the SMACNA "HVAC Duct Construction Standards", Third Edition 2005, and as herein specified. Tables and figures referred to hereinafter are taken from the SMACNA publication.

B. Duct Pressure Classes: As shown on drawings. Where no specific duct pressure class designations are provided on drawings, the 2 inch water gauge pressure class is the basis of compliance with the standards, regardless of velocity in the duct, except when the duct is variable volume supply or designated exhaust. All variable volume ducts upstream of VAV boxes have a 3 inch WG basis of compliance when the drawings do not give pressure class. All AC unit discharge plenums of VAV systems shall have a 6 inch WG basis and the ductwork to the first branch take-off a 4 inch WG basis of compliance when the drawings to do indicate a pressure class. Negative pressure ductwork between lab hoods and exhaust fan inlet shall be 5 inch water gauge pressure class. Snaplock construction is not permitted. Refer to NFPA for Smoke Exhaust Ductwork Gauge Requirements.

C. Casings and Plenums: Casing and plenum sheet metal gauges, reinforcing and construction details shall be in accordance with Figures 6-1 through 6-12. Intake and exhaust plenums shall be sealed liquid tight and drained. Where through-louver drainage cannot be achieved, a 1 inch drain connection with serviceable 3 inch deep trap, shall be provided within a heated space to prevent freezing, and piped to the nearest floor drain.

Bottom of plenums shall pitch toward drainage openings.

D. Hangers and Supports: Ductwork sheet metal supports shall be in accordance with Chapter IV, including all plenum and casing sheet metal which is suspended.

E. Sealing: All duct joints and air device connections shall be sealed in accordance with Table 1-2 except that all supply systems shall be sealed Class A. The sealant shall be Hardcast 550 with imbedded fabric, except for joints with dissimilar metals then a lead gasket shall be provided. Louver plenums shall be sealed water tight to a height of 12 inches above the plenum bottom.

F. Branch Take-Offs: Branch main take-offs for round ductwork shall be 45 degree lateral tap and where terminal boxes occur, shall be 45° angle entry in accordance with Figure 2-6.

G. Elbows: Elbows for round ducts shall be stamped type elbows with centerline radius equal to 1.5 times duct diameter. Where space is limited, the centerline radius may be reduced to 1.0 times the diameter for only those ducts entering into corridor ceiling spaces from vertical duct shafts. Elbows for rectangular and oval ductwork shall have a centerline radius equal to 1.5 times the duct width.

1. Where space is restricted, square throat elbows with single or double thickness turning vanes may be used. Elbows shall be in accordance with Figure 2-2 except that throat types RE-4, RE-6, RE-7, RE-9 and RE-10 are specifically prohibited. Provide an access door upstream of all square throat elbows with single (or double) thickness turning vanes.

H. Transitions and Offsets: Transitions in round ducts shall be conical reducers. Transitions in rectangular ducts shall be in accordance with Figure 2-7 except that offset type 1 and offset type 2 are specifically prohibited.

I. Flexible Connections: Flexible connections shall be in accordance with Figure 2-17. Flexible connectors shall be installed to provide alignment of equipment and devices with ducts in operating positions. Provide on the inlet and outlet side of all air moving equipment incorporating rotating elements. Connections shall be of glass fiber reinforced neoprene captured by a fingered metal band at each edge. Maintain a maximum three inch (3") separation and a minimum 1½ inch separation between the connected devices such that a standard four inch (4") connector will be installed slack.

J. Access Doors: Access doors in sheet metal ducts shall be provided with sash locks. Access doors in casings and plenums shall be provided with Type 2 locks (handles). All doors shall be hinged. Door insulation shall match adjacent casings. Doors shall be provided on all plenum and mixing sections, fire dampers, smoke dampers, combination fire/smoke dampers, reheat coils (inlet side), air valves and terminal filter equipment.

K. Volume Dampers: Volume dampers shall be in accordance with SMACNA except that, in addition to those indicated on drawings, each branch main and branch shall be provided with damper typical to locations indicated in Figure 2-1. Additional dampers shall be provided where shown on plans, details and where specified elsewhere. Damper gauge to be two (2) gauges heavier than the duct in which they are mounted. Provide with locking quadrants or push rods and pillow blocks as appropriate. Dampers shall be sufficiently large to extend the full width of the branch duct to which it is attached. Provide scooped profile.

L. Fire Dampers and Smoke Dampers: Fire and smoke dampers shall be in accordance with National Fire Code NFPA 90A Standard requirements and bear an Underwriters label. Dampers shall be installed in accordance with manufacturer's installation

instructions. Dampers shall be UL listed, labeled, and shall be dynamic-static designed in accordance with UL Standard 555. Dampers shall be listed to support the appropriate fire rating required for wall and/or floor penetrations served. Dampers in lined ducts shall be in accordance with Figure 2-22. Where required as a condition of damper listing, provide slip joint. To permit breakaway, no screws, rivets, bolts or other fasteners shall be used; each joint shall have an access door as applicable. Provide an access door in the duct to service fusible link. Access doors for insulated ducts shall be double wall insulated sandwich type. Fire dampers shall be out of air stream Type B or C. Combination fire/smoke dampers may be used in lieu of separate dampers. All smoke dampers and combination fire/smoke dampers shall be furnished with pneumatic or electric actuators and appropriate UL label. Provide 10 gauge welded sleeve where dampers can not be placed directly into the fire and/or smoke wall.

M. All smoke dampers and fire/smoke dampers shall be supplied with electric/electronic actuators, 165 degree F. “McCabe Link” (for use in general HVAC ductwork), 185 degree F. “McCabe Link” (for use in smoke control exhaust ductwork). All fire/smoke dampers shall be capable of being reset remotely. All fire/smoke dampers shall be supplied with one (1) end switch that will indicate both full closed and full open. All fire/smoke dampers shall fail open upon loss of control signal. All smoke dampers shall fail closed upon loss of control signal.

1. Except where specifically noted otherwise, the maximum permissible pressure drop for any fire damper at air flow quantity required by Design Documents shall not exceed 0.1 inches of water.
2. Except where specifically noted otherwise, the maximum permissible pressure drop for any smoke damper assembly at air flow quantity required by design documents shall be as follows:
   a. Up to 1,000 FPM — 0.05 Inches of Water
   b. 1,000 to 2,000 FPM — 0.10 Inches of Water
   c. Over 2,000 FPM — 0.20 Inches of Water
3. Damper sizes shall be adjusted accordingly where required to reduce pressure drop.
4. Installed dampers found to have pressure drops in excess of specified values shall be replaced at no additional cost to the Owner.

N. All fire, smoke and combination fire/smoke dampers shall be dynamically rated for the following conditions:

1. Fan (VAV) Discharge to Terminal Units — 3,500 FPM
2. Fan (CV) Discharge to Reheat Coils — 1,500 FPM
3. Terminal Box/Reheat Coil Discharge to
   a. Terminal Device (i.e. Diffuser) — 1,000 FPM
4. Return/Exhaust Terminal Device
   a. (i.e. Register) to fan inlet — 1,800 FPM

O. Exposed Ductwork: All ductwork exposed to view, except in mechanical rooms, shall not be cross-broken or beaded. Where reinforcement cannot be eliminated by using heavy duty gauge, it shall be internal. Seams shall be of non-standing type and duct shall be cleaned and degreased to accept application of paint.

P. Flexible Ductwork: Shall be manufactured in accordance with UL-181, Class 0 and the amended Standards of NFPA 90A. The flexible ductwork shall be tested and listed by UL under these standards.

1. Ductwork shall be fabricated of minimum 0.0065” thick, grade 3003 aluminum alloy incorporating a “0” temper.
2. Spiral construction shall incorporate a continuous grooved seam, flat pipe lock, doubled over, to create an effective triple locking joint. Double locking seams

shall not be accepted.

3. Corrugations formed into the spiral tape impart rigidity and shall support duct flexibility. Corrugations shall not exceed 3% of the nominal duct diameter.
4. Joints for securing to ductwork and/or equipment collars shall incorporate a reinforcing band around the circumference of the flexible duct and its connection point. Self-tapping sheet metal screws shall extend through the reinforcing band through the connecting collar, sandwiching the flexible ductwork between. Final air sealant shall be provided by Hardcast 550 with imbedded fabric.
5. Where associated ductwork is specified to be insulated, matching thickness insulating jacket, complete with vapor barrier, shall be used.
6. Length of flexible duct shall not exceed 48 inches except where specifically noted otherwise on drawings.
7. Flexible ductwork shall not be used in conjunction with ductwork rated for 6 inches WG and higher. Flexible duct shall not be installed to penetrate any walls, ceilings, roofs, or floors.
8. The intent of this specification section is to allow the use of flexible ductwork as a final connection to a terminal device. Bends shall not exceed 90 degrees or have a radius less than inside diameter of duct.

Q. Exhaust systems serving bathrooms, shower rooms and similar rooms where the exhaust air may contain a high moisture content shall be constructed of aluminum and shall be sealed watertight and pitched to prevent any accumulation of moisture. Provide a trapped drain at all low points and at the base of each riser.

R. Exhaust systems serving laboratory exhaust hoods shall be constructed of Type 316 stainless steel with externally welded, liquid tight joints, unless indicated otherwise on the drawings.

S. Provide 24 gauge piping sheet metal protective covers, shields or saddles to protect piping insulation. Protective covers shall totally encapsulate any and all exposed HVAC piping within six feet (6') of finished floor. Shields and saddles shall extend a minimum of six inches (6") ahead and behind the projected footprint of the pipe support addressed and shall completely cover the lower 180° arc of the insulated piping.

T. Acoustic Liner:

1. All ductwork noted on plans t be acoustically lined, shall have one-inch (1") thick "ToughGard R" duct liner with enhanced surface. Acoustical liner shall be composed of rotary-type glass fibers for superior acoustic performance. The fibers shall be bonded together with a thermosetting resin into a insulation blanket which is overlaid with a durable, water repellent, fire-resistant black composite air stream surface.
2. Acoustic liner shall comply with ASTM C1071 for air velocities up to 6000 FPM.
3. Acoustic liner shall comply with ASTM C1104 for vapor sorption.
4. Acoustic duct liner shall have a minimum NRC rating of 0.70.

Note: Duct dimensions shown are of clear inside dimensions after application of liner.

2.38 SHEET METAL WORK (HIGH VELOCITY SYSTEMS)

A. General: High velocity systems shall be fabricated and installed in accordance with recommendations contained in the latest edition of the SMACNA "High Pressure Duct Construction Standards" and as herein specified. Tables and figures referred to hereinafter are taken from the SMACNA Publication.

B. Ductwork: Ductwork sheet metal gauges, transverse joint construction and intermediate reinforcing shall be in accordance with Figure 2-2 for round ductwork and Table 4-3 for rectangular ductwork with welded joints.

C. All duct joints shall be sealed in accordance with recommendations of Chapter 5 for the sealant used.

D. Supports: Ductwork sheet metal supports shall be in accordance with Chapter 6.

E. Branch Take-Offs: Branch main take-offs for round ductwork shall be 45 degrees lateral and where terminal boxes occur shall be conical tees in accordance with Figure 2-5.

F. Elbows, Transitions and Offsets: Elbows for round ducts shall be stamped type elbows with centerline radius equal to 1.5 times duct diameter. Where space is limited the centerline radius may be reduced to 1.0 times the diameter for only those ducts entering into corridor ceiling spaces from vertical duct shafts. Elbows for rectangular ducts shall be radius type in accordance with Chapter 4. Where space is restricted, square throat elbows may be used in accordance with Chapter 4. Transitions in round ducts shall be conical reducers. Transitions in rectangular ducts shall be in accordance with Figure 4-18.

G. Volume Dampers: Volume dampers shall be similar to those specified for low velocity ducts.

H. Fire dampers and smoke dampers shall be in accordance with Chapter 4 with the damper designed to be outside main air stream in a housing extension. Dampers shall be UL listed and labeled for appropriate fire rating required for rating of wall or floor penetration served. Dampers shall be provided with hinged access doors adjacent to linkages. Where fire dampers cannot be placed directly into fire wall, then 10 gauge black steel welded extension housing shall extend to actual damper location. Dampers shall be located in straight duct sections and installed in accordance with the manufacturer's installation requirements.

I. Flexible ductwork shall be in accordance with UL 181 Class 1 construction and shall be spiral wire reinforced fabric with liquid sealant and clamps to secure it to connecting ductwork or equipment collars. Where associated ductwork is specified to be insulated, insulating jacket, complete with vapor barrier, shall be used. Use manufacturer's recommendations for sealing and securing joints at insulated flexible ducts. When unsupported length of flexible duct exceeds 6 feet, provide 1½ inch galvanized sheet metal saddles under fiberglass duct with sheet metal or aluminum strap supporting saddles from structural framing above. In no case shall hanger spacing exceed 6 feet. Bends shall not exceed 90 degrees or have a radius less than inside diameter of duct

2.39 SLEEVES, INSERTS AND OPENINGS

A. General:

1. All penetrations for piping, ductwork and conduit in the building walls, floors and roof shall have sleeved or boxed openings except for interior wall of gypsum board and stud construction which are not fire or smoke rated.
2. The HVAC Subcontractor shall be responsible for informing this Contractor of the construction schedule as to permit orderly inclusion of all sleeves, openings and inserts. The HVAC Subcontractor shall furnish and install all sleeves, boxed openings and inserts as the work progresses. If the HVAC Subcontractor fails to provide the sleeves, boxed openings and inserts, he shall bear the cost of modifications necessary for their inclusion.

3. All cutting and patching shall be done by this Contractor. The HVAC Subcontractor shall not cut into any building construction without first having received permission from the Architect.

B. Sleeves:
1. This Contractor shall furnish all sleeves for the work and furnish all labor for installation.
2. Sleeves through exterior building walls or through concrete construction shall be Schedule 40 (galvanized) steel pipe. Sleeves through interior fire or smoke rated walls of gypsum and stud construction shall be 10 gauge sheet metal.
3. Sleeves shall be sized to provide a total of not less than 1/2 inch clearance around the piping, duct or conduit together with any insulation cover.
4. Sleeves for setting into walls shall be flush with finished construction. Sleeves for setting into floors shall be imbedded in concrete slab and extend approximately 1 inch above finished floors. Sleeves through floors of mechanical rooms shall be 12 gauge and shall extend 4 inches above the floor. Sleeves shall be provided with lugs or flanges to permit firm attachment to the building construction. Wall sleeves shall not be used as support points.
5. All sleeved openings within the building shall be sealed airtight using fire barrier caulking with a UL classification for use as a fire barrier penetration seal for walls and floors with up to a three-hour fire rating, expanded into place for the full depth of the sleeve. Sleeved openings through exterior walls and floor shall also be sealed outside using waterproof mastic.

C. Inserts:
1. Inserts or other type anchoring devices shall be provided for the support of piping, ducts, or equipment in masonry or concrete construction. Inserts shall be as specified under pipe supports.
2. The HVAC Subcontractor shall furnish and install all inserts.

D. Openings:
1. Openings shall be framed or boxed by the HVAC Subcontractor.
2. Floor openings into mechanical rooms shall be provided with 4 inch high concrete curbs around the entire opening perimeter. All wall openings shall be flush with both surfaces.
3. Fire damper frames to be set into masonry or concrete construction shall be set into place at the time of the construction of the respective floor or wall. Exterior plywood covers shall be applied to both sides of fire dampers to prevent damage prior to making duct connections.
4. Openings for the passage of ducts and piping shall have 1/2 inch clearance all around the finished piping or duct and insulation. Boxed openings for gang piping shall be provided with 18 gauge sheet metal on both sides of penetration secured to the opening perimeter cut to fit the pipe shape and the clearance space within the opening filled with fire barrier caulking with a UL classification for use as a fire barrier penetration seal for walls and floors with up to a three-hour fire rating, expanded into place so as to make the penetration airtight.

E. Escutcheon Plates: Escutcheon plates shall be provided for all pipe penetrations into finished spaces as follows:
1. Pipe penetrations shall have chromium plated spun or pressed brass two-piece hinged escutcheon covers sized to fit the piping and insulation (if any) outside diameter and cover pipe sleeve.
2. Duct penetrations shall be 28 gauge stainless steel strips fastened with stainless steel screws or bolts and sized to cover the duct with any insulation and the wall

opening. Round ducts shall be provided with escutcheon plates as indicated above for piping.

3. Penetrations through finished floors shall have matching finish extension escutcheon sleeves sized to the escutcheon and finished in a neat, workmanlike manner.

2.40 SOUND ATTENUATORS

A. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer. Silencers shall be Vibro-Acoustics, IAC, United McGill or VAW.

B. Alternate manufacturers must request and obtain written approval by the Engineer to bid the project at least 10 days prior to the bid due date. As a condition of pre-approval, alternate manufacturers must submit to the Engineer a minimum of twenty (20) different HVAC silencer test reports. Each report shall be for a silencer tested in full accordance with the ASTM E-477-99 silencer test standard in an aero-acoustic test facility which is NVLAP accredited for the ASTM E477-99 standard. Each test shall have been conducted within the last 12 month period. A copy of the laboratory's NVLAP accreditation certificate must be included with the submitted reports. Any changes to the specifications must be submitted and approved in writing by the Engineer at least 10 days prior to the bid due-date.

C. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.

D. Elbow Silencers: All elbow silencers, including models REFL shall be constructed with an 18 gauge galvanized steel outer casing (unless HTL casing is specified) and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.

E. Rectangular Silencers:

1. All rectangular silencers shall be constructed with a 22-gauge galvanized steel outer casing and 26 gauge galvanized perforated steel liner.

F. Acoustic Media:

1. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be used to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conforming to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

G. Media Protection;

1. Media shall be encapsulated in glass fiber cloth to help prevent shedding, erosion and impregnation of the glass fiber.

H. Silencer materials, including glass fiber, shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

1. Flamespread Classification: 15
2. Smoke Development Rating: 5

I. Silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and 10-gauge outer protective metal skin to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

J. Silencers shall be constructed in accordance with ASHRAE and SMACNA Standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in "Section B Materials" are minimums. Material gauges shall be increased for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

1. Casings shall be lockformed and sealed, except as noted in Section B Materials, to provide leakage resistant construction. Airtight construction shall be achieved by u se of a duct-sealing compound supplied and installed by the Contractor at the job site.
2. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

K. Acoustic Performance:

1. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.
2. Silencer generated noise shall not be greater than that listed in the silencer schedule.
3. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
4. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

L. Silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E-477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

M. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.

1. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-99 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-99 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

2.41 STRAINERS

A. Strainers shall be provided where shown on the drawings and as specified herein. Equipment shall be as manufactured by Sarco, RP&C, Mueller, Armstrong or Barnes and Jones.

B. Strainers shall be provided on inlets to all pressure regulating valves, temperature control valves and makeup water control valves. Strainer baskets shall be heavy duty perforated type with openings sized as recommended for the line size and service by the manufacturer. All strainers 2½ inch size and larger shall be provided with blow-down valves. Blow-down valves shall be ball valves, exception high and medium pressure steam service where gate valves specified for service shall be used. Blow-down valves shall have short nippled outlets angled down toward floor. Strainers on horizontal steam lines shall have to be installed with basket section installed horizontally and blow-down connections rotated to basket low point.

C. Strainers for all services, except as otherwise specified, shall conform to the following:
   1. Strainers on lines 2 inches and smaller shall have 250 working steam pressure bronze bodies with screwed ends.
   2. Strainers on lines 2½ inches and larger shall have 125 working steam pressure semi-steel bodies with flanged ends.

D. Strainers for high pressure steam and medium pressure steam service shall conform to the following:
   1. Strainers on lines 2 inches and smaller shall have 600 pound cast steel
   2. Strainers on lines 2½ inches and larger shall have 300 pound cast steel bodies with flanged ends

2.42 SUPPLEMENTAL SUPPORT SYSTEM

A. This Contractor shall provide all supplemental supports required to direct equipment and materials support loads to approved structural load bearing points. All mechanical equipment and systems shall be substantially supported without distortion or excessive vibration. The methods of support shall be as hereinafter described, except as otherwise noted on the drawings.

B. The supplemental support system shall be substantial type with members sized to prevent equipment distortion or excessive vibration. The HVAC Subcontractor shall provide support components such that all equipment shall operate without objectionable noise or vibration being transmitted to the structure.

C. The supplemental support system shall conform to requirements of this specification. Manufacturer's published characteristics referenced are intended as a guide only. The supplier shall verify support elements submitted are in accordance with specified materials and construction and are appropriately sized to accept and direct the proposed loading.

D. All supplemental support elements shall be by one (1) manufacturer: Unistrut, B-Line or Telestrut. The acceptable standard or quality shall be as follows:
   1. Framing Members:
      a. Nominal Size: 1⅝" x 1⅝" "U" channel
      b. Body: Mild Carbon Steel, ASTM A570 Grade 33
      c. Gauge: 12 Gauge (0.105" thick)
      d. Slot Width: 7/8" nominal
      e. Pre-Punching: 9/16" Diameter, 1⅛" on center, 3 sides

f. Finish: Hot-Dipped Galvanizing, G90 weight, ASTM A123
g. Conformance: Metal Forming Manufacturers Association (MFMA) Standard Publication MFMA-1.

2. Fittings:
a. Nominal Size: 1⅝" (length per device)
b. Shape: Per Service from Manufacturer's Standard Catalog
c. Body: Hot Rolled Mild Carbon Steel, ASTM A570, Grade 33
d. Gauge: 1/4" Nominal Thickness
e. Hole Size: 9/16" Nominal
f. Finish: Hot Dipped Galvanizing, G90 weight, ASTM A123
g. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1

3. Accessories:
a. Nominal Size: Per Service from Manufacturer's Standard Catalog
b. Shape: Per Service from Manufacturer's Standard Catalog
c. Body: Hot Rolled Mild Carbon Steel, ASTM A570, Grade 33
d. Gauge: 1/4" Nominal Thickness
e. Hole Size: 9/16" Nominal
f. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1.
g. Rollers: Gray Cast Iron

4. Nuts and Bolts:
a. Nominal Size: 1/2" diameter x (Size per device)
b. Body: Mild carbon steel, ASTM A570, Grade 33, and Case Hardened
c. Threading: Coarse, Unified & American, UNC Classes 2A and 2B
d. Mounting: Spring or non-spring
e. Finish: Electro-Galvanized, G90 weight, ASTM A123
f. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1

E. Supplemental support system members shall be positioned to align with equipment support points for proper bolting.

2.43 TERMINAL BOXES

A. Single duct type with hot water coils:
1. Terminal Casing
Furnish and install Titus, Enviro-Tec or Metal-Aire, single duct terminals of sizes and capacities (CFM) indicated on the drawings. Terminals shall be constructed of not less than 24 gauge zinc-coated steel, mechanically assembled and sealed to form an air-tight casing; maximum air leakage of 2 % at 3" w.g. Spot-welded casings are not acceptable. Interior walls of the terminal casing shall be lined with 1/2 -inch dual-density fiberglass with 4 pounds per cubic foot skin density, rated for a maximum air velocity of 4500 fpm. Insulation must meet all requirements of UL 181 and NFPA 90-A. Raw edges exposed to the airstream shall be coated and sealed. Sound power data shall be submitted with no corrections or noise reduction factors applied.
2. Air Control Valve Assembly
Terminal air control valve shall be dual-wall construction, consisting of two (2) metal thicknesses with ½-inch dual-density insulation sandwiched between, creating an effective radiated sound barrier. Insulation shall be as specified for terminal casing. The control blade of the air valve shall be 16-gauge, designed to operate through a 45-degree arc. Multi-blade dampers and single blade

volume controllers (operating through 90º) are not acceptable. The control blade shall be bolted or welded to a continuous shaft which rotates in self-lubricating nylon bearings. Blade shall close against a closed-cell gasket seat; it shall be preloaded to insure a tight seal. Blade shall not deflect at inlet pressures up to 6" w.g. Eliptical or oval dampers are not an acceptable substitution.

3. Controls
Terminal unit control shall be furnished by the ATC Contractor and factory installed by the terminal box manufacturer. See ATC Specification Paragraph 2.51. The terminal box manufacturer shall bear all costs associated with mounting the controls. Terminal boxes shall be provided with a sheetmetal control enclosure. Provide a factory-applied typed label unique to each VAV terminal box indicating DDC address, TAG, maximum flow setting, minimum flow setting.

4. Pressure-Independent Models with Pressure Differential Controller
Pressure differential reset controller shall maintain setpoint (CFM) within 5%, regardless of system pressure change. CFM limiting devices are not acceptable. The reset controller shall constantly monitor thermostat input, air flow (CFM), and system static and total pressures in a manner as to minimize under-or over-controlling in relation to the space temperature requirements. The reset controller shall be capable of field adjustment of minimum and maximum CFM settings without the use of tools. Flow curve for field balancing shall be affixed to terminal casing. Differential flow taps and factory-set CFM shall be provided is so noted at terminal schedule on the drawings. Controller shall maintain pressure independence to as low as .03" w.g. Averaging sensor shall be mounted in the inlet of the terminal and shall provide a minimum of one air pickup point for each 2-1/2" of inlet diameter. Single-point differential sensors are not acceptable.

5. Hot Water Coil
Terminals shall include a hot water coil. Coil shall be attached to the terminal with slip-and-drive connection, to allow removal for maintenance or cleaning. Coil shall be constructed of pure aluminum fins of .005" to .010" thickness, with die-formed spacers. Fins shall be mechanically fixed to .017" copper tubes for maximum heat transfer. Coils shall be tested at 320 p.s.i.g. air-under-water.

2.44 THERMOMETERS

A. Thermometers shall be of sizes, types and capacities specified herein, and shall be located as indicated on the drawings. Equipment shall be as manufactured by Taylor Company, Mueller Company or Foxboro Company.

B. Thermometers shall be industrial type with 9 inch scale, red perma colored liquid, black scale divisions on white background, union hub, separable brass well and adjustable swivel base. Provide extension wells on insulated lines. Locate wells so as to provide minimum restriction to flow.

C. Thermometer ranges shall be as follows:

Hot Water (All)	30-240 Degrees F.
Chilled Water	0-110 Degrees F.
Makeup Water	0-110 Degrees F.

Note: Mount all thermometers so as to be read from the floor. Provide two (2) spare thermometers of each range indicated.

2.45 UNIT HEATERS

A. Unit heaters shall be of sizes, capacities for the throw and mounting heights indicated on the drawings. Equipment shall be of manufacturer and size scheduled on the drawings, or approved equal as manufactured by Sterling, Vulcan, Rosemex or Rittling.

B. Horizontal unit heaters shall have direct driven propeller fan, steel fan guard, vertically adjustable louvers, horizontally adjustable fins and built-in motor thermal overload protection.

C. Vertical unit heaters shall have direct driven propeller fan, steel fan guard, adjustable outlet diffusers and built-in motor thermal overload protection.

2.46 VALVES

A. All valves shall conform to requirements of this specification for the services indicated. Manufacturer's numbers referenced are intended as a guide only. The supplier shall verify valves submitted are in accordance with specified materials and construction.

B. All valves of a given type shall be by one (1) manufacturer. The acceptable standard of quality shall be as follows.

C. Gate Valves: Jenkins, Grinnell or Crane

Nominal Size	Through 2"	2½" and above
Service	Steam Condensate, Chilled Water Condenser Water & Hot Water	Steam Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM B-62 Bronze; Threaded	ASTM A-126 Class B; Flanged
Bonnet	ASTM B-62 Bronze; Rising Stem	ASTM A-126 Class B; Bolted OS&Y
Bolts	N.A.	ASTM A-307
Gaskets	N.A.	Non-Asbestos Graphite/Aramid Fiber
Packing	Non-Asbestos Graphite/Aramid Fiber	Non-Asbestos Graphite/Aramid Fiber
Stem	ASTM B-371 Alloy C69400 or ASTM B-99 Alloy C65100 H04	ASTM B-16 UNS-C36000
Wedge	ASTM B-62 Bronze	ASTM A-126 Class B Cast Iron
Conformance	WW-V-54 Class A, Type I & MSS-SP-80	WW-V-58 Class 1, Type 1 & MSS-SP-70

D. Globe Valves: Jenkins, Grinnell or Crane

Nominal Size	Through 2"	2½" and above
Service	Steam Condensate, Chilled Water Condenser Water & Hot Water	Steam Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM B-62 Bronze; Threaded	ASTM A-126 Class

		B; Flanged
Bonnet	ASTM B-62 Bronze; Rising Stem	ASTM A-126 Class B; Bolted OS&Y
Bolts	N.A.	ASTM A-307
Gaskets	N.A.	Non-Asbestos Graphite/Aramid Fiber
Packing	Non-Asbestos Graphite/Aramid Fiber	Non-Asbestos Graphite/Aramid Fiber
Stem	ASTM B-371 Alloy C69400	ASTM B-16 UNS-C36000
Seat Disc	ASTM B-62 Bronze	ASTM B-584 Alloy C84400 Bronze or ASTM A-126 Class B Cast Iron
Seat Ring	N.A.	ASTM B-584 Alloy C84400 Bronze
Conformance	WW-V-51 Class A, Type I & MSS-SP-80	MSS-SP-85

E. Butterfly Valves: Jamesbury, Grinnell or Rockwell

	Two-Way	Three-Way
Nominal Size	3" and above	3" and above
Service	Bubble Tight, Dead End for Steam, Condensate, Chilled Water, Condenser Water & Hot Water	Bubble Tight, Dead End for Steam, Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM A-395 60-40-18 or ASTM A576 65-45-12 Ductile Iron; Lug Style	ASTM A-395 60-40-18 or ASTM A576 65-45-12 Ductile Iron; Lug Style
Liner	Ethylene Propylene Diene Monomer	Ethylene Propylene Diene Monomer
Disc	ASTM A-351	ASTM A-351
Disc Coating	Ethylene Propylene Diene Monomer	Ethylene Propylene Diene Monomer
Shaft	ASTM A-276 Type 316 Stainless Steel	ASTM A-276 Type 316 Stainless Steel
Bearings	ASTM B-584 Alloy C93200 Bronze	ASTM B-584 Alloy C93200 Bronze
Bushings	ASTM B-584 Alloy C93200 Bronze	ASTM B-584 Alloy C93200 Bronze
Operator	Infinite Lever w/Memory Stop (to 6"φ); Chain Wheel w/Gear Operator (above 6"φ)	Chain Wheels w/Gear Operators Interconnected
Conformance	MSS-SP-67 & 46CFR56.20-15(b)(1)	MSS-SP-67 & 46CFR56.20-15(b)(1)

F. Ball Valves: Jamesbury, Grinnell or Watts

Nominal Size	To 3" φ
Service	Steam, Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG Steam, 400 PSIG WOG
Body	ASTM B-584 Alloy 845 Bronze, Threaded (to 2"φ) or Soldered (2½"φ & 3"φ)
Thrust Washer	Reinforced Polytetrafluoro ethylene
Ball	ASTM B-584 Alloy 845 Bronze; Full Port
Seats	Reinforced Polytetrafluoro ethylene (Teflon)
Stem	ASTM B-371 Alloy 694 Silicon Bronze
Packing	Reinforced Polytetrafluoro ethylene (Teflon)
Packing Nut	ASTM B-16
Operator	Infinite Lever w/Memory Stop
Conformance	WW-V-35, Type II, Class A, Style 3

G. Swing Check Valves: Grinnell or Watts

Nominal Size	2½" and above
Service	Steam, Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG
Body	ASTM A-126 Class B; Flanged
Bonnet	ASTM A-126 Class B; Bolted
Bolts	ASTM A-307
Gaskets	Non-Asbestos Graphite/Aramide Fiber
Disc	ASTM B-584 Alloy C84400 Bronze
Hanger	ASTM B-584 Alloy C84400 Bronze
Seat Ring	ASTM B-584 Alloy C84400 Bronze
Conformance	MSS-SP-71 Type I

H. Silent Check Valves: Grinnell or Watts

Nominal Size	2½" and above
Service	Condensate, Chilled Water, Condenser Water & Hot Water
Pressure Rating	125 PSIG @ 200°F., 230 PSIG WOG
Body	ASTM A-48 Class 35; Globe Style, Flanged
Stem	ASTM A-582 Alloy S30300 Stainless Steel
Disc	ASTM B-584 Alloy 836 Bronze
Spring	ASTM A-313 T304 Stainless Steel
Seat Ring	ASTM B-584 Alloy 836 Bronze
Conformance	N.A.

I. Temperature Control Valves: Shall be provided by the Automatic Temperature Control Subcontractor in conformance with the standards specified above. Valves shall be installed by the HVAC Contractor in accordance with the requirements of the ATC Subcontractor.

J. Valves five inches (5") and larger shall be independently supported.

K. Sprocket Wheels and Chains: Sprocket wheels and chains shall be furnished and installed on all hand operated valves 2½ inches in diameter and larger which cannot be operated from any mechanical room floor.

2.47 VARIABLE FREQUENCY DRIVES

A. General
1. The Contractor shall provide a complete adjustable frequency controller as indicated on the drawings.
2. The Contractor shall be responsible for the installation and start-up of the equipment covered by this specification.
3. The adjustable frequency controller shall be furnished by a single vendor who has actively been manufacturing adjustable frequency controllers for a period of at least five (5) years.
4. Complete drawing shall be furnished for approval and shall consist of master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices operating in conjunction with the adjustable frequency controllers. Suitable outline drawings showing details necessary to located conduit stub-ups and field wiring shall be furnished for approval before proceeding with manufacture.
5. The adjustable frequency controller shall be UL and CSA certified and shall comply with the latest applicable standards of ANSI, IEEE, NEMA and national Electrical Code.
6. Adjustable frequency controller manufacturer shall maintain and staff engineering service, within one hundred (100) actual miles of the site, to provide start-up service, emergency service calls, repair work, service contracts, maintenance and troubleshooting training of customer personnel.

B. Construction
1. The adjustable frequency controller shall be rated 460 volt, 3 phase, with feature and options as specified.
2. The adjustable frequency controller shall be rated for the motor HP as shown on the drawings. The controllers shall provide digitally-based speed adjustment of three phase motors. The adjustable frequency and voltage output shall provide constant volts per hertz excitation of the motor up to 60 hertz.
3. The adjustable frequency controllers shall have a 110% overload rating for one (1) minute, every ten (10) minutes and a 140% overload rating for two (2) seconds, every fifteen (15) seconds.
4. The controller shall be capable of converting incoming 3 phase, 460 volt (+10%) and 60 hertz (+/- 2 hertz) power to a fixed potential DC bus level. The DC voltage shall be inverted by a full wave diode bridge rectifier or a pulse width modulated (PWM) inverter to an adjustable frequency output. The controller shall maintain power factor at .95 or greater at any speed or load. The controller shall have a minimum efficiency of 95% at rated load. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan (variable torque) control.
5. The adjustable frequency AC controller shall employ a full wave rectifier to prevent line notching, for conversion of AC power to DC power. The inverter section shall use Insulated Gate Bipolar Transistors (IGBT) (p -n substrate) as switching devices. The IGBT, operating as a MOS-gated, input inverted Darlington transistor with a MOSFET (n -n substrate in n-channel enhancement mode) input shall support high input impedance, low drive power and fast

(40+k/sec) switching speeds. The bipolar output stage shall enable low conduction losses with high currents. A DC bus choke and DC capacitors shall control internal harmonic generation.

a. Silicon controller rectifies (SCR's), current source inverters and paralleling of devices are unacceptable.

6. Sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no de-rating. This voltage vector control shall be designed to minimize harmonics to the motor to maximize motor efficiency and life.
7. The inverter shall operate in an ambient temperature of 0ºC to 40ºC for elevations up to 3,300 feet above sea level and humidity of 0% to 95% non-condensing.
8. The controller enclosure shall be NEMA 1, wall-mounted. The controller shall have easily removable assemblies and shall be front accessible. No side clearance shall be required for cooling of wall mount units and all power and control wiring shall be done from the bottom.
9. All enclosures shall be not less than 16-gauge steel with surfaces to be thoroughly cleaned and phosphatized prior to painting. They shall be primed with a corrosion-resisting coating. Cabinet finish paint to be ANSI 161.
10. Doors shall include plastic device holders for mounting up to six (6) operator devices. Factory mounted operator devices shall be factory wired.
11. The operating handle of the disconnect switch shall always remain connected to the breaker and shall not be mounted on the door. The position handle shall indicate ON, OFF or TRIPPED condition of the circuit breaker. The handle shall have provisions for padlocking in the Off position with at least three (3) padlocks. Interlock provisions shall prevent unauthorized opening or closing of the controller door with the disconnect handle in the ON position.
12. All logic control boards shall be interchangeable.
13. The VFD and options shall be tested to ANSI/UL Standard 508. the complete VFD, including all specified options, shall be listed by a nationally recognized testing agency such as UL, ETL.
14. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for sixty (60) seconds and 220% of rated current for up to one (1) second while starting.
15. Drive shall be capable of operating a motor up to 1,000 feet away without de-rating or field modification. Provide detuning output filters and shielded cabling.

C. Interface

1. Start, stop and speed control potentiometer terminations.
2. Linear independent timed acceleration and deceleration adjustable.
3. Non-isolated process signal follower for 0-10 VDC control of output frequency.
4. Variable torque performance from 2 to 60 hertz.
5. Frequency stability of 0.5% for twenty-four (24) hours with voltage regulation of +/-2% of maximum rated output voltage.
6. Individual door-mounted lights or LED's for indication of run, power on and interruption due to over-current, over-voltage, over-frequency, under-voltage, over-temperature and phase loss.
7. 115 volt AC isolated control power for operator devices.
8. Motor slip dependent speed regulation.
9. Logic power carryover during utility loss shall be sufficient to extend double the interval required for internal losses to decay the load inertia to zero.
10. Insensitive to input line rotation.
11. Fixed dwell time at start to increase motor starting torque.
12. Auto restart to automatically restart on phase loss, over-voltage and under-voltage

trips only.

13. Local/Hand, Stop/Reset and Remote/Auto selector switches shall be provided to start and stop the drive and determine the speed reference.
14. Provide a 24 VDC, 40 mA max, output signal to indicate that the drive is in Remote/Auto mode.
15. Digital manual speed control. Potentiometers are not acceptable.
16. Lockable, alphanumeric backlit display keypad. VFD's up to 300 HP shall use the same control panel.
17. A quick setup menu with preset parameters shall be provided on the drive.
18. The drive shall be fitted with RS 485 serial communications port and be supplied with software to display all monitoring, fault, alarm and status signals. The software shall allow parameters changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters.
    a. The drive shall be fully able to communicate with PLC's, CDS's and DDC's. DDC's shall be able to monitor drive feedback signals which shall include, but shall not be limited to:
        i. Output Speed/Frequency
        ii. Current (in amperes)
        iii. Torque
        iv. Power
        v. Kilowatt-Hours
        vi. Relay Outputs
        vii. Diagnostic Faults
19. The RS 485 serial communications port and software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters.
    a. Serial communications shall include, but shall not be limited to:
        i. Run-Stop Control
        ii. Speed Set Adjustment
        iii. Proportional-Integral Controller Adjustment
        iv. Current Limit
        v. Acceleration/Deceleration Time Adjustment.
20. Set point control interface (Proportional-Integral-Derivative (PID) control) shall be standard in the unit.
21. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
22. An elapsed time meter with kWh meter shall be provided.
23. The following displays shall be accessible from the control panel in actual units.
    a. Reference Signal Percent
    b. Output Frequency
    c. Output Amps
    d. Motor Horsepower
    e. Motor Electrical Demand (kW)
    f. Motor Electrical Energy Consumption (kW-hr)
    g. Output Voltage
    h. Drive Temperature (% until trip)
    i. Motor speed expressed in engineering units per application (in percent speed, GPM, CFM).
24. Drive will sense the loss of lead and signal a no load/broken belt warning or fault.
25. The VFD shall store in memory the last three (3) minimum faults and record all operational data.
26. Minimum six (6) programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
27. Minimum six (6) programmable relay outputs shall be provided for remote

indication of drive status.

28. Two (2) programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 VDC, 0-20 mA and 4-20 mA.
29. Two (2) programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
30. The VFD shall accept an external contract closure command. Through an integrally mounted Interface Terminal Block (ITB), to automatically disable the VFD and transfer the motor to full line signal. Automatic by pass shall be used to permit the facility fire alarm system to override the normal VFD operation and default to nominal motor speed.

D. Protective characteristics
1. Input AC circuit breaker with an interlocked pad lockable handle mechanism.
2. AC input line current limiting fuses for fault current protection of AC to DC converter section.
3. Electronic cover-current trip for instantaneous overload protection.
4. AC input line under-voltage and phase loss protection.
5. Over-frequency protection.
6. Over-temperature protection.
7. Surge protection form input line transients.
8. Electrical isolation between the power and logic circuits, as well as between the 1150 volt AC control power and the static digital sequencing.
9. Ability to withstand output terminal line-to-line short circuits without component failure.
10. dV/dT and dI/dT protection for converter semi-conductors.
11. Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
12. Protection against input transients, loss of AC line phase, short circuit, ground fault, over voltage, under voltage, drive over temperature and motor over temperature. The VFD shall display all faults in plain English. Codes are not acceptable.
13. Protect VFD from sustained power or phase loss. The VFD shall incorporate a five (5) second control power loss ride through to eliminate nuisance tripping.
14. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
15. Drive shall have semi-conductor rated input fuses to protect power components.
16. The drive shall be fitted with output line reactors to limit the rate of output voltage rise over time (dv/dT), reduce motor operating temperature and RFI and EMI. To prevent breakdown of the motor winding insulation, the dV/dT must be below 1500 V/μsec per IEC recommendations. The supplier shall include with the quotation the dV/dT values of the drive.
17. Drive shall be capable of starting into a rotating load operating forward or reverse up to full speed. VFD shall be capable of accelerating or decelerating to set point without safety tripping or component damage (flying start).
18. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

E. Independent Adjustability
1. VFD shall have an adjustable carrier frequency of 1 to 12 kHz through 75 HP and 3 kHz (fixed) above 75 HP.
   a. Minimum Speed: 4 to 60 hertz.
   b. Maximum Speed: 40 to 90 hertz/
2. Three (3) variable-torque V/Hz patterns shall be provided with the ability to select a constant torque start pattern for each of them.

a. Volts per hertz: Adjustable from 3.83 to 11.5 volts per hertz.

3. Twenty (20) preset speeds shall be provided.
4. Minimum two (2) acceleration and two (2) deceleration ramps shall be provided. The shape of these curves shall be adjustable.
   a. Acceleration: .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
   b. Deceleration: .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
   c. The VFD shall also accept remote input acceleration and deceleration rams via direct digital programmable inputs.
5. If VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset and restart.
   a. Over voltage.
   b. Under voltage.
   c. Current limit.
   d. Inverter overload.
   e. Motor overload.
   f. Loss of input signal.

   The number of restart attempts shall be selectable from 9 to 5 (minimum) and the time between attempts shall be adjustable for 0 to 120 seconds.
6. Four (4) current limit setting shall be provided.
7. Low frequency Boost: Up to 60 volts at 2 Hz.

F. Bypass
1. Provide a manual by pass consisting of a door interlocked main fused disconnect pad lockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors.
   a. The DRIVE position shall allow the motor to be operated at an adjustable speed form the drive.
   b. The OFF position shall allow the motor and drive to be disconnected.
   c. The LINE position shall allow the motor to be operated at full speed form the AC power line. Power shall be disconnected from the drive, so that service can be performed.
   d. The TEST position shall allow the motor to be operated at full speed from the AC line power. This shall allow the drive to be given an operational test while continuing to run the motor at full speed in bypass.
2. External normally closed dry contact shall be interlocked with eh drives safety trip circuitry to stop the motor whether the DRIVE or BYPASS mode in case of an external safety fault.

G. Required Options
1. Full time adjustable current limit shall sense an overload on the motor when current exceeds a preset limit. Output frequency, and therefore motor speed, shall be reduced. If current decreased with speed, the speed shall decrease until current drops below the limit. Once current is reduced to normal, the frequency shall return to the original setting.
2. AC output contactor.
3. Motor over current relay.
4. Isolated process signal follower for use with grounded input process signal.
5. Output load ammeter, voltmeter and speed indicating meters.
6. Door mounted NEMA 4 operator controls with heavy duty industrial rated devices.
7. Process control output signal of 0-10 VDC, proportional to controller frequency, including gains and bias adjustments.
8. Controller status relay with two (2) Form C relay pairs, rated 2 amps resistive at

115 volt AC for indication of "ON" condition.

9. Bypass contactor arrangement with overload relay complete with all control circuitry to disconnect the controller from the motor and reconnect the motor to line power, after a suitable time delay, when initiated manually.

H. Quality Assurance
1. To ensure quality and minimize infantile failures at the job site, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.
2. All optional features shall be functionally tested at the factory for proper operation.
3. Provide a written copy of the factory start-up results for inclusion in the close-out documentation.

I. Compliance to IEEE-519
1. The variable (adjustable) frequency drive manufacturer shall provide calculations specific to this installation showing that the Total Harmonic Distortion for the VFD's, reflected into the electrical distribution system is limited to the level defined by IEEE-519 (latest edition) for general systems. Harmonic analysis shall be included with VFD submittal to support the request for approval from the Engineer.
   a. The calculations shall proceed from Owner-provided power quality and harmonics information for all retrofit, renovation and restoration projects.
2. The VFD manufacturer shall conduct on-site harmonic measurements before and after start-up of the VFD's. Results of the measurements, showing the harmonic contribution of the VFD's, shall be provided to the Engineer as part of the Project Commissioning, prior to Final Acceptance by the Owner.
3. If site measurements show that the IEEE-519 levels have been exceeded:
   a. New Facilities:
      i. The VFD manufacturer shall provide proper filtering to attain the IEEE-519 levels, at no additional cost to the Owner.
   b. Existing Facilities:
      i. Should the quality of the existing power be consistent with the Owner-provided information, the VFD manufacturer shall provide proper filtering to attain the IEEE-519 levels, at no additional cost to the Owner.
      ii. Should the quality of the existing power be inconsistent with the Owner-provided information, the VFD manufacture shall provide recommendations concerning proper filtering to attain the IEEE-518 levels, for consideration by the Owner.
4. Three phase alternating current input line reactors shall be provided as a minimum with all VFD's. The line reactors are to provide attenuation of the line side voltage transients, and shall prevent overload trips or other unnecessary VFD shutdowns, and provide a reduction in harmonic distortion.
5. Inlet line reactors shall be:
   a. 2-1/2% line impedance (minimum).
   b. 150% continuous current rating for one (1) minute.
   c. Saturation rating of not less than 2.5 times the continuous current rating.
   d. UL listed.

J. Approvable Manufacturers: The variable (adjustable) frequency AC drives shall be manufactured by Graham, Square D, Asea Brown Boveri, Cutler Hammer or Mitsubishi.

K. The HVAC Subcontractor shall provide written confirmation of coordination of drives and motor starters of all equipment with the Electrical Subcontractor.

2.48 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. Provide vibration isolation and seismic restraint systems as identified by the requirements of this section and the contract documents. Attention is directed to the structural, architectural, mechanical and electrical documents which identify HVAC equipment and systems requiring vibration isolation treatment and seismic restraint.

B. The HVAC Subcontractor shall provide vibration isolation components such that all equipment shall operate without objectionable noise or vibration being transmitted to the structure.

C. The HVAC Subcontractor shall provide seismic restraint of non-structural building components (HVAC). Restraint systems are intended to withstand the stipulated seismic accelerations applied through the component's center of gravity.

D. The work in this section includes the following:
1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Certification of seismic restraint designs and installation supervision.
7. Conform to vibration isolation and seismic restraint types herein specified.

E. Examine the contract documents for sizes, horsepowers, rotational speeds, equipment location, length of span between columns and beams and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.

F. Conform to the requirements of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks, "HVAC Applications" 1995 Edition; Chapter 43 "Sound and Vibration Control", and Chapter 50 "Seismic Restraint Design".

G. Isolators and restraints of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

H. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. All performance of products (such as strut, cable, anchors, and clips) associated with restraints must be supported with manufacturer's data sheets or certified calculations.
2. Seismic restraint calculations must indicate specific code paragraph references (see CODE AND STANDARDS REQUIREMENTS) for each acceleration criteria. Seismic calculations shall indicate the component values required to determine the force to be restrained ($F_p = A_v\ C_c\ P\ a_c\ W_c$). Specifically, A_v value from Contour Map, USE GROUPS, SEISMIC HAZARD EXPOSURE GROUP, SEISMIC PERFORMANCE CATEGORIES, MECHANICAL, ELECTRICAL COMPONENT AND SYSTEM SEISMIC COEFFICIENT (C_c) Attachment Amplification Factor (a_c) AND PERFORMANCE CRITERIA FACTOR (P) must be determined and the resultant values shall be clearly indicated in the certified calculations. Note: For roof mounted equipment both the seismic acceleration and wind load shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.
3. Seismic restraint calculations must be provided for all connections of equipment to the structure. Performance of all products (such as strut, cable, anchors, and clips)

associated with restraints must be supported with manufacturer's data sheets or certified calculations.

4. Seismic restraint calculations must be based on the acceleration criteria shown in **TABLE A** acting through the equipment's center of gravity.
5. For roof mounted equipment both the seismic acceleration and wind loads (30 psf) shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.
6. Certification of calculations to support seismic restraint designs must be stamped by a professional engineer registered to practice in the Commonwealth of Massachusetts, with at least five years of seismic design experience.
7. Analysis must indicate calculated dead loads, derived loads and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.
8. An in-force $1,000,000.00 coverage limit Seismic Design Errors and Omissions insurance certificate must accompany submittals. Manufacturer's product liability insurance certificates are not an acceptable substitution.

I. Manufacturer of vibration isolation and seismic control equipment shall assume the following responsibilities:
   1. Determine vibration isolation and seismic restraint sizes and locations.
   2. Provide equipment vibration isolation and seismic restraints as specified. Furnish manufacturer's product data covering each isolator and restraint type for style, characteristics, and finish.
   3. Guarantee specified isolation system deflections.
   4. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.
   5. Isolator quantities, dimensions, deflections, capacities and type shall remain the responsibility of the manufacturer and the Contractor.

J. Provide project specific catalog cuts and/or data sheets on the vibration isolators and restraints proposed for inclusion on this project. Reference each and every "TYPE" and detail each compliance with this specification.
   1. Provide an itemized list of all isolated and non-isolated equipment. Provide detailed schedules showing isolator and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.
   2. Show base construction for equipment; include dimensions, structural member sizes and support point locations.
   3. When walls and slabs are used as seismic restraint locations, details of acceptable methods for duct and pipe must be included.
   4. Indicate isolation devices selected with complete dimensional and deflection data before condition is accepted for installation.
   5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
   6. Coordination or contract drawings shall be marked-up with the specific locations and types of restraints shown for all pipe and duct. Rod bracing at various installation angles and assigned load at each restraint location shall be clearly delineated. Any and all tributary loads shall be considered for proper restraint sizing.
   7. For ceiling suspended equipment provide minimum/maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.

8. Calculate thrust for fan heads, for axial and centrifugal fans, to determine whether thrust restraints are required.

K. Housekeeping pad attachment shall be by the project Structural Engineer. Material and labor required for attachment and construction shall be by the Division 3 subcontractor.
   1. Housekeeping pads shall be coordinated with the Seismic Restraint vendor and sized to provide a minimum edge distance of 10 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.

L. Supplementary support steel and connections shall be provided by the HVAC Subcontractor for all equipment, piping, and ductwork including roof mounted equipment, as specified.

M. The HVAC Contractor shall provide restraint attachment plates to the General Contractor, to be cast into housekeeping pads, concrete inserts, double sided beam and clamps by the Division 3 Subcontractor, in accordance with the requirements of the Seismic Restraint vendor.

N. Definitions:
   1. The term EQUIPMENT will be used throughout this specification and it includes ALL non-structural HVAC components within the facility and/or serving this facility, such as equipment located in out buildings or outside of the main structure on grade within five feet of the foundation all. Equipment buried underground is excluded. Entry of services through the foundation walls is included. Equipment requiring vibration isolation and seismic restraint includes, but is not limited to, the following:
      a. Air cooled condensing units
      b. Rooftop air handling units
      c. Air separators
      d. Boilers
      e. Cabinet heaters
      f. Ductwork
      g. Fans (all types)
      h. Motor control centers
      i. Piping
      j. Pumps (all types)
      k. Rooftop units
      l. Tanks (all types)
      m. Unit heaters
      n. Variable frequency drives
      o. Chillers
      p. Cooling towers
      q. NOTE: HVAC equipment and systems not listed herein above are still included in this specification.
   2. Life Safety Systems defined:
      a. All systems involved with fire protection such as fire dampers.
      b. All systems involved with and/or connected to emergency power supply including smoke evacuation.
      c. All medical and life support systems.
      d. Fresh air relief systems on emergency control sequences including air handlers, ductwork, and dampers.
   3. Positive attachments are those locations at which equipment, piping, and

ductwork are tied to the facility structural elements by incorporating:
   a. Cast-in or wedge type expansion anchors, or
   b. Double sided beam clamps, or
   c. Welded or through bolted connections to the structure.
4. Transverse bracing are those restraints applied to limit motion perpendicular or angular to the centerline of the pipe or duct.
5. Longitudinal bracing are those restraints applied to limit motion along the centerline of the pipe or duct.

O. Substitution of internally or externally isolated and restrained equipment in lieu of the isolation and restraints specified in this section is acceptable provided all conditions of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certified per the section on Seismic Restraints and Analysis stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.
1. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the preceding.
2. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure. This attachment and certification thereof shall be by this section.

TABLE A

"G" FORCES FOR VARIOUS CONDITIONS
(SEISMIC ZONE 2 - AV > 0.1 ≤ 0.2

PIPE AND DUCT	RIGIDLY MOUNTED EQUIPMENT	FLEXIBLY MOUNTED EQUIPMENT	ALL LIFE SAFETY
.25	.40	.40	.60

P. All vibration isolation and seismic devices described in this section shall be the product of a single manufacturer. Mason Industries shall be considered the Base Manufacturer of these specifications for the purposes of establishing a standard of equality; products of other manufacturers are acceptable provided their systems strictly comply with intent, structural design, performance and deflections of the Base Manufacturer.

Q. Seismic Restraint and Vibration Isolation Devices:
1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the “G” forces as determined by the seismic certification and calculations as described in this section of the specifications.
2. Corrosion protection for outdoor applications shall be as follows:
   a. Springs cadmium plated, zinc electroplated or electrostatically deposited, baked enamel powder coated.
   b. Hardware cadmium plated.
   c. All other metal parts hot spray or hot dipped galvanized.
3. Seismic Restraint Types:
   a. All seismic restraint devices shall maintain the equipment in a captive position and shall not short circuit isolation devices during normal operating conditions.
   b. All seismic restraint devices shall have provisions for bolting and/or welding to the structure.
   c. Welding of springs to isolator housing, base plans is strictly prohibited.
   d. TYPE I: Spring Isolator – Restrained

i. Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.
ii. Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.
iii. Ductile top cut with adjusting bolt tapped for equipment attachment locking cap screw.
iv. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
v. Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
vi. Internal spring adjusting nut or bolt with leveling capability.
vii. Built-in all-directional limit stops with minimum 1/4" clearance under normal operation.
viii. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
ix. Cast or aluminum housings, (except ductile iron) are not acceptable.
a) Mason Industries, Type SLR

e. Type II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an all directional resilient pad limit stop. Restraints shall be fabricated of plate, structural members or square metal tubing. Angle bumpers are not acceptable.
i. Mason Industries Type Z-1225/Z-1011

f. Type III: Restraints for suspended systems:
i. Vibration isolated systems shall be braced with multiple 7 x 19 strand galvanized cable rope.
a) Mason Industries Type SCB
ii. Non-isolated systems shall be braced with structural steel strut type with approved fastening devices to equipment and structure.
a) Mason Industries Type SSB
iii. Steel angles (by HVAC Subcontractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint vendor's submittals. Steel angles shall be attached to the rods with a minimum of three ductile iron clamps at each restraint location. Welding of support rods to angles is not acceptable. Rod clamp assemblies shall have Anchorage Preapproval "R" number from California OSHPD.
a) Mason Industries Model SRC
iv. Pipe clevis cross braces are required at all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the clevis cross bolt. Clevis cross braces shall have Anchorage Preapproval "R" number from California OSHPD.
a) Mason Industries Model CCB

g. Type IV: Double deflection neoprene isolator encased in ductile iron or steel casing.
i. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
a) Mason Industries Type RC or BR

h. Type V: Rigid attachment to structure utilizing wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with

wedge type expansion bolts, for welding. Powder shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with manufacturer's published standards.

4. Vibration Isolator Types:
   a. Type A: Spring Isolator – Free Standing
      i. Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.
      ii. Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.
      iii. Ductile top cut with adjusting bolt tapped for equipment attachment locking cap screw.
      iv. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
         a) Mason Industries Type SLF
   b. Type B: Spring Isolator – Restrained
      i. Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.
      ii. Reserve deflection (from published load ratings to hold height) of 50% of the rated deflection.
      iii. Ductile top cup with adjusting bolt tapped for equipment attachment locking cap screw.
      iv. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
      v. Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
      vi. Internal spring adjusting nut or bolt with leveling capability.
      vii. Built-in all-directional limit stops with minimum 1/4" clearance under normal operation.
      viii. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
         a) Mason Industries Type SLR, SSLFH
   c. Type C: Spring Hanger Isolator
      i. Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection. Spring element shall have a steel upper spring retainer and a lower elastomer retainer cup with an integral bushing to insulate lower support rod from the hanger box.
      ii. Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.
      iii. Steel hanger box shall be capable of 30 degree misalignment between the rod attachment to structure and the connection to the supported equipment. Hanger boxes shall withstand three times the rated load without failure.
         a) Mason Industries Type 30
   d. Type D: Double deflection neoprene isolator encased in ductile iron or steel casing.
      i. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
         a) Mason Industries Type RC or BR
   e. Type E: Elastomer Hanger Isolator
      i. Molded neoprene element with an integral bushing to insulate lower support rod from the hanger box.
      ii. Steel hanger box shall withstand three times the rated load

without failure.
a) Mason Industries Type HD

f. Type F: Combination Spring/Elastomer Hanger Isolator
i. Spring and neoprene elements in a steel hanger box with the features as described for Type C and E isolators.
a) Mason Industries Type 30N

g. Type G: Pad type elastomer isolator
i. Neoprene pad shall have 0.75" minimum thickness, deflection rating of 0.1 inch under rated load. Supports shall be connected in the center by a 1/8" tear strip to facilitate trimming to desired size in two inch increments.
ii. 1/16" galvanized steel plate between multiple pad layers.
iii. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
iv. When bolting is required for seismic compliance, neoprene and duck washers and bushings shall be provided to prevent short circuiting of bolt.
a) Mason Industries Type Super Waffle (SW) pad

h. Type H: Pad type elastomer isolator
i. Laminated canvas duck and neoprene maximum loading 1000 psi, minimum 1/2" thick.
ii. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
iii. When bolting is required for seismic compliance, neoprene and duck washers and bushings shall be provided to prevent short circuiting.
a) Mason Industries Type HL Pad

i. Type I: Thrust Restraints
i. A spring element same as Type A shall be combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting thrust movement of air moving equipment to 1/4".
ii. Restraints shall be easily converted in the field from a compression type to tension type.
iii. Unit shall be factory pre-compressed.
a) Mason Industries Type WB

j. Type J: Telescoping Riser Guide
i. Telescoping arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
a) Mason Industries Type VSG

k. Type K: Resilient Pipe Anchors and Guides
i. All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
ii. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction.
iii. Allowable loads on neoprene pad shall not exceed 500 PSI and the design shall be balanced for equal resistance in any direction.
a) Mason Industries Type ADA

l. Type M: Flashable restrained isolator
i. Shall have all features of Type B isolator.
ii. Shall have waterproof spring covers for adjustment or removal of springs.

iii. Unit shall have a structural top plate for welding or bolting of supplementary support steel.
iv. Isolator shall accept 2" roofing insulation and be flashed directly into the waterproofing membrane.
v. To be complete with wood nailer and flashing.
a) Mason Industries Type RFS.

m. Type P: Elastomer Isolator
i. Double deflection neoprene compression mountings shall have all metal surfaces neoprene coated.
ii. Non-skid top and bottom surfaces.
iii. Threaded bolting sleeves shall be embedded in the isolator.
iv. Drilled tie-down bolt holes shall be provided in the base plate.
a) Mason Industries Type ND

5. Equipment Bases:
a. All curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria and shall also be capable of resisting a minimum psf wind loads (non-simultaneous).
b. Type B-1: Integral Structural Steel Base:
i. Constructed of structural members to prevent base flexure at equipment startup and misalignment of driver and driven units. Perimeter members shall be a minimum of 1/10th the longest unsupported span.
ii. Centrifugal fan bases shall be complete with motor slide rails and drilled for driver and driven units.
iii. Height saving brackets shall be used to reduce operating height and maintain 1" operating clearance under base.
a) Mason Industries Type MSL, WFSL
c. Type B-2: Concrete Inertia Base
i. Steel concrete forms for floating foundations. Bases for pumps shall be large enough to support elbows and/or suction diffusers. The base depth shall be a minimum of 1/12 the longest unsupported span, but not less than 6" or greater than 12".
ii. Forms shall include concrete reinforcement consisting of steel bars or angles welded in place on 8" centers both ways in a layer 1½" above the bottom.
iii. Isolators may be set into pocket housings which are an integral part of the base construction or utilize height saving brackets set at the proper height to maintain 1" clearance below the base.
iv. Base shall be furnished with steel templates to hold anchor bolt sleeves and anchors while concrete is being poured.
a) Mason Industries Type KSL or BMK
d. Type B-3: Spring Roof Curb
i. Spring isolation curbs that bear directly on the roof support structure and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturers or field fabricated curbs shall not be used.
ii. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Disassembly of the weather and air seal to gain access to the isolators is not acceptable.
iii. Springs shall have all of the features of Type B.
iv. Curbs shall have continuous sheet metal sides and have

provision for 2" insulation to be installed and furnished by the Roofing Contractor.

v. Waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing membrane and joined at the corners by EPDM bellows.

vi. Wood nailer and flashing shall be provided.

vii. Shall have a California OSHPD Seismic Anchorage Preapproval "R" number.

viii. Shall include a means of incorporating a sound barrier package, supported from the top isolated rail consisting of two layers of waterproof gypsum board furnished and installed by the General Contractor.

ix. Contractor shall have the option of ordering the curb built to the roof pitch or field leveled in accordance with all seismic provisions of this section.

x. Overhung condensing units (when applicable) shall be supported by Type B isolators and spanning (width) steel support angle. These isolators shall in turn be supported on a field built curb (by others).

a) Mason Industries Type RSC

e. Type B-4: Flashable Roof Rail System – Isolated

i. Continuous structural support rails that combine equipment support and isolation mounting into one unitized assembly.

ii. Rails shall incorporate Type B springs which are adjustable, removable and interchangeable after equipment has been installed.

iii. The system shall maintain the same installed and operating height with or without the equipment load and shall be capable of being utilized as a blocking device.

iv. The entire assembly shall be an integral part of the roof's membrane waterproofing.

v. Unit to be supplied with continuous upper and lower galvanized flashing.

a) Mason Industries Type RIR

f. Type B-5: Not Used.

g. Type B-6: Non-isolated roof curb

i. Same as B-3 without spring isolation.

a) Mason Industries Type URC

h. Type B-8: Non-isolated.

i. Same as continuous support rails, Type B-4 without the spring isolation.

a) Mason Industries Type RUR

i. Type B-9: Steel Rails

i. Steel members of sufficient strength to prevent equipment flexure during operation.

ii. Height saving brackets to reduce operating height.

iii. Rails shall be cross braced at support and equipment attachment points when used in seismic zones.

a) Mason Industries Type R, ICS

6. Flexible Connectors:

a. All connectors shall be installed on the equipment side of shutoff valves; horizontal and parallel to equipment shafts whenever possible. Piping shall be supported and/or anchored to resist pipe movement beyond the

allowable movement of the flexible connector.

b. Installations must include check valves and/or other design and installation precautions to reduce the threat to life safety when subjected to the specified seismic accelerations.

c. Type FC-1: Spherical Elastomer Connector
   i. Manufactured of peroxide cured EPDM in the covers, liners and polyester tire cord frictioning. Curing must take place in steel molds closed within heated hydraulic presses.
   ii. Solid steel rings shall be used within the raised faced rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
   iii. Sizes 2" and larger shall have two spheres reinforced with a molded-in ductile iron external ring between spheres. Bolted-on strap type reinforcing are not acceptable.
   Flanges shall be split ductile iron with hooked or similar interlocks. Sizes 16" to 24" may be single sphere.
   iv. Threaded one piece bolted flange assemblies with female threaded ends for sizes 3/4" to 1½".
   v. Rated at 250 psi up to 170° F. with a uniform drop in allowable pressure to 170 psi at 250° F. for sizes through 14". 16" through 24" single sphere minimum ratings are 180 psi at 170° F and 130 psi at 250°F.
   vi. Factory tested at 150% of rated pressure for 12 minutes before shipment. Safety factor to burst and flange pullout shall be a minimum of 3:1.
   vii. Concentric reducing expansion joints with equal ratings and features may be substituted.
   viii. Connectors shall be installed in piping gaps equal to the length of the connector under pressure.
   ix. Control rods are required in unanchored installations where the installation exceeds the pressure requirement without control rods.
      a) Control rods shall have 1/2" thick neoprene washer bushings large enough in diameter to take the thrust at 1,000 psi maximum on the washer area.
   x. Connectors bolted to Victaulic type coupling or gate, butterfly or check valves to have a minimum 5/8" flange spacer (by others) installed between the connector and the coupling flange. Connectors must mate to a flat faced flange in all instances.
      a) Mason Industries SAFEFLEX Type SFU, SFEJ, SFDEJ or SFDCR

d. Type FC-2: Flexible Stainless Steel Hose
   i. Stainless steel hose and braid rated with 3:1 safety factor.
   ii. 2" diameter and smaller with male nipples, 2½" and larger with fixed flat faced steel flanges.
   iii. Lengths shall be: 9" for 2½" through 4"; 11" for 5" and 6"; 12" for 8"; 13" for 10"; 14" for 12" through 16".
      a) Mason Industries Type BSS

e. Type FC-3: Upbraided Exhaust Hose
   i. Low pressure stainless steel annularly corrugated with one floating and one fixed flanged end.
   ii. Maximum temperature of 1500 degrees F.
      a) Mason Industries Type SSE

f. Type FC-4: Flexible Bronze Braided Hose
   i. Metal hose and braid rated with a minimum 3:1 safety factor.

(Minimum 150 PSI)

ii. Copper tube ends.

a) Mason Industries Type BBF

2.49 WATER FLOW MEASURING DEVICES

A. Flow meter fittings shall be installed as indicated on the drawings and in the following piping systems and locations for balancing and testing purposes:

1. Each chilled water, condenser water and hot water pump or common manifold for paralleled pumps with full stand by.
2. Each chilled water cooling coil.
3. At condenser water and chilled water piping to each chiller.

B. Venturi fittings for 3/4 inch through 2 inch flow fittings shall have NPT connections for threaded pipe and the 2½ inch through 10 inch flow fittings shall fit between a pair of pipe flanges with gaskets, nuts and special bolts. All flow fittings shall have “slide valve” enabling fitting to be used with portable flow meter, gauge, purge and drain attachment and cleaning attachment and when withdrawn shall automatically close the “slide valve”.

C. Provide combination balancing valve and flow device where indicated on the drawings or specified. Flow device - valve assembly shall have ball valve construction of bronze, suitable for use as bubble-tight service valve, calibrated balance setting indicator plate, shrader valve connections with caps for meter hose connections. Units shall be Taco circuit setters.

2.50 WATER SYSTEM ACCESSORIES

A. Equipment shall be sized for the service indicated on the drawings. Equipment shall be as manufactured by Bell & Gossett, Armstrong, Taco, or Thrush.

B. Piping system air vents shall be provided with indicated on drawings and at high points of all hot water and chilled water piping sections. Vents shall be as manufactured by Bell & Gossett, Armstrong, Taco, or Thrush. Any vents not accessible shall be piped to an accessible location.

1. Air vents, except where noted otherwise, shall be manual air vents suitable for 150 PSIG system pressure as manufactured by Bell & Gossett #4V coil-operated type.
2. Air vent at the high point of each system shall be high capacity industrial automatic air vents of the float type with drain connection for water overflow as manufactured by Armstrong, Model #1-AV, B&G 107 or Spirax Sarco 13W.

C. Provide adjustable type water make-up pressure regulating valves for each water system indicated on the drawings and not noted to be furnished under Section 15000. Valves shall be as manufactured by Bell & Gossett #6; Taco #335 or Thrush #21.

1. Valves shall be suitable for minimum of 125 psi inlet pressure and shall be adjustable to the system pressure.
2. Valves shall be provided with assemblies consisting of inlet pressure gauge, shut-off valves, inlet strainer, outlet pressure gauge and quick fill bypass with globe valves.

2.51 AUTOMATIC TEMPERATURE CONTROLS

A. General

1. Furnish and install, as hereinafter specified, a native BACnet, Web-Based Direct Digital Control (DDC), automatic temperature control system as manufactured by

Johnson Controls or approved equal.

2. The DDC Contractor shall be fully licensed at the time of bid to do business in the job site area. The DDC Contractor must be either a wholly owned factory branch office or a licensed dealer of the manufacturer's listed above with a technical staff, complete spare parts inventory, and test and diagnostic equipment to keep systems in operation 24 hours per day, seven days per week. He shall have emergency service available in the local area for temperature control systems for which he is currently performing on-call emergency service 24 hours per day, seven days per week. Wholesale, distributor, or representative type ATC Contractors are unacceptable. This requirement will be strictly enforced.
3. It is the responsibility of the ATC sub-contractor to provide a fully operable system. Any components required for specified operation that are not provided by equipment manufacturers shall be provided by the ATC sub-contractor, regardless of equipment manufacturer's specification.

B. Scope of Work

1. The ATC contractor shall furnish and install all equipment, accessories, and wiring required for a complete and functioning web based building management system.
2. The control system shall consist of, but not limited to all temperature controls as specified herein including all CPU's, DDCP's, CRT's, printers, sensors, software, thermostats, valves, actuators, dampers, damper operators, relays, control panels, and other accessory equipment and appurtenances, including electrical wiring, to fulfill the intent of the specifications and provide for a complete and operable system.
3. Provide actuators for equipment such as dampers and inlet guide vanes where such actuators are not provided by the equipment manufacturers. Refer to floor plans for location and numbers of required actuators. Actuators shall be Belimo, or equal. Coordinate requirements with the HVAC subcontractor.
4. All materials and equipment used shall be standard components, regularly manufactured for this type of work and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.
5 The Contractor shall furnish and install all control and interlock wiring for chillers, boilers, fuel oil, day tanks, alarms, and emergency generators unless specifically and clearly stated to be provided by others.
6. The ATC contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and systems operation and to verify the quantities and types of dampers, operators, alarms, and bells he has to provide. Numerous references to the ATC contractor are made throughout this specification identifying work to be performed under the HVAC section in addition to work specifically indicated under this paragraph. It will be assumed that, if no specific inquiries are made during the bidding period, the HVAC/ATC subcontractors have reviewed all requirements and interfaces between equipment and controls, to result in a complete, integrated and fully operational HVAC system.
7. The Automatic Temperature Control Contractor shall provide one (1) copy of ADS server software to be installed on customer provided server, located in Technology Office.
8. The automatic temperature control contractor shall furnish and install power meters. Meters shall be networked into the building management system and shall provide point mapping of all available data to the new workstations. Meters shall be manufactured by Veris Model H8206. Exact location and installation of meters shall be coordinated with electrical sub-contractor.

9. The ATC contractor shall provide one year warranty for entire Building Management System, commencing on date of final acceptance.
10. Include manufacturer's agreement to provide necessary programmed maintenance and to maintain systems for one year from date of final acceptance, within contract sum.
11. As part of above maintenance provide 24 / 7 active monitoring of up to 60 I/O points resident in the system. BAS technicians dedicated to performing this service and be on-line on a continuous basis 24 / 7 / 365. This service shall be provided remotely via the web access LAN connection provided by the Town of Beverly. Access to Beverly Middle School LAN shall be provided via a VPN connection.

C. Work by Others
1. Automatic temperature control valves, duct humidifiers and separable wells for immersion elements furnished by the control manufacturer shall be installed by the HVAC contractor under the ATC contractor's supervision.
2. Automatic dampers that are specified to be furnished by the ATC contractor shall be installed by the HVAC subcontractor, under the ATC contractor's supervision.
3. Concrete foundations shall be provided by the general contractor. The HVAC Contractor shall furnish dimensional drawings to the general contractor.
4. All finished painting required for the temperature control piping and equipment, shall be by the general contractor.
5. All cutting and patching necessary for the installation of the temperature control system, shall be by the HVAC contractor.
6. Installation of duct smoke detectors shall be by the HVAC subcontractor, under the ATC contractor's supervision.

D. Submittals and Shop Drawings
1. Submit shop drawings and obtain written review comments before ordering or installing any equipment or material.
2. Submit shop drawings of all equipment. Shop drawings shall consist of but not limited to manufacturer's scaled drawings, valves and damper schedules, cuts and catalogs, including descriptive literature which shall indicate the construction, material, physical dimensions and complete operating data. All ATC shop drawings shall also contain a written description of the Sequence of Operations, enumerating and describing the function of each component.
3. Submit the following for approval:
    a. Control drawings with detailed wiring diagrams, including bills of materials and written sequences of operation, for each system type.
    b. Valve and damper schedules showing sizes, configurations, capacities, pressure drops and locations of equipment. Include type and quantities of actuators.
    c. Data sheets for control system components.
    d. Complete software information including names of software packages provided, control sequences performed, complete information on user programmability (commands, language details, and programming sequences), and detailed printouts of the actual software within each DDCP including user definable comment statements inserted throughout the program to guide a novice operator through the various sequences of the actual program.
    e. Graphics samples in full color clearly indicating level of detail to be provided on this project.
    e. Calculations for valve coefficients (CVs).
    f. Operators user's manuals.
    g. Complete point-to-point check-out procedures to ensure that all physical

points are consistently tested and verified for this project.

E. Equipment Operation Instruction and Maintenance Manuals
   1. On completion and acceptance of the work, furnish for approval three copies of written instructions on the proper operation and maintenance of all equipment and apparatus furnished under this section.
   2. Each manual shall be provided with an index sheet listing the contents in alphabetical order and shall contain but not limited to the following material:
      a. Updated copies of all submittal data and shop drawings as specified previously.
      b. Manufacturer's instructions regarding the installation, maintenance and calibration of each component used in the ATC system installed by the ATC contractor.
      c. Copies of all warranties and guarantees issued by each equipment manufacturer.
      d. "As-built" interconnecting wiring diagrams and wire lists of the field installed system with complete, properly identified numbering of each system component and device.
      e. A set of "User's Manual" detailing the operation of the Building Management and Control System (BMCS). The manual shall describe the hardware operation as well as provide instructions in computer access and programming. This manual shall be submitted under separate cover. The User Manual shall be written for an inexperienced user. It shall describe in layman's language, the functions and procedures of "using" the system.

F. Acceptance Testing
   1. At substantial completion of the work, the ATC contractor shall prepare a punch list of all items remaining to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the ATC contractor to complete all work in accordance with the contract documents. This list shall be delivered to the engineer prior to the ATC contractor's request for formal acceptance testing.
   2. Additionally, the ATC contractor shall provide an equipment list and point list to the engineer prior to formal acceptance testing. Each material item and point must be initialed by the installing DDC technician that the item has been physically inspected for proper installation, functionality, and database entry.

      The verification form shall be similar to the following:

DDC Floor	Point Cabinet #	Point Name	Point Type	Point Address	Sensor On/Off	Oper. Reading	Test Initials	Test Time	Test Date

   3. The engineer will prepare a list of items to be corrected or completed that shall include the punch list items identified by the ATC contractor, and any additional items found to be incomplete or incorrect. All items on both lists shall be completed or corrected before acceptance testing may proceed. The ATC contractor shall notify the engineer when he is ready to proceed with the acceptance test that system is complete and operates per the requirements of the contract documents.
   4. Acceptance Test Procedure:
      a. The ATC contractor shall demonstrate in the presence of the Engineer that all functions of the ATC and BMCS systems are operating as specified in the contract documents, including any required change orders. The final checkout will include, but not be limited to, the following

items:

1) Verification of the location, calibration and proper wiring/connection of all BMCS input and output devices.
2) l BMCS software and output functions shall be tested individually.
3) The proper operation and calibration of all ATC devices and actuators shall be verified individually.
4) When system performance is deemed satisfactory by the Architect, system parts shall be accepted for beneficial use. Warranty shall begin. All minor deficiencies found will be noted in writing by the Engineer. All deficiencies so noted shall be corrected by the ATC contractor before the final acceptance will be issued.
5) The ATC contractor shall allow sufficient time to complete the acceptance test procedure.

b. Acceptance testing shall be coordinated with the Commissioning Agent. Refer to specification section 019100 for additional requirements.

G. Training/Owner′s Instruction

1. The ATC contractor shall provide three copies of an operator's user's manual describing all operating and routine maintenance service procedures to be used with the system as specified previously. The ATC contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than 40 hours and shall take place at the site. The training sessions shall be delineated such that at least 16 hours of training occur after the completion of system testing and balancing and commissioning. This training shall include instruction in the use and operation of the point editor function and graphics.
2. Training sessions shall be coordinated with the Commissioning Agent. Refer to specification section 019100 for additional requirements.

H. Warranty

1. The ATC contractor shall guarantee the control system free from defects in material and workmanship and guarantee performance of the systems per the requirements of the contract documents for one year of normal use and service beginning on the date the Owner has accepted the system.
2. The ATC contractor shall through the warrantee period, schedule visits to the site in order to provide two seasonal system review sessions with the building operators. The intent is for system review to take place at the time of seasonal system changeover. The contractor shall establish diagnostic trend logs on the OWS for the purposes of evaluating all major systems in the building, and a sample of terminal systems. Following any calibrations and adjustments the logs shall be submitted to the Architect for review.
3. As part of above maintenance provide 24 / 7 active monitoring of up to 60 I/O points resident in the system. BAS technicians dedicated to performing this service and be on-line on a continuous basis 24 / 7 / 365. This service to be provided remotely via the web access LAN connection provided by the Town of Abington. Access to Abington Co-Located Pre-K Middle High School LAN to be provided via a VPN connection

I. Products

1. The Building Management and Control System (BMCS) shall consist of Network Level 1 controllers and Level 2 DDC controllers to monitor and control equipment per the control sequences. Level 1 controllers shall provide overall system coordination, accept control programs, perform automated DDC and energy

management functions, control peripheral devices and perform all necessary mathematical functions. The controller shall be a microcomputer of modular design. The word size shall be 16 bits or larger, with a memory cycle time of less than 1 microsecond. Level 1 controllers will share information with and from the entire network of Level 1 and Level 2 controllers for full global control. Level 1 controllers shall permit multiuser operation from workstations and laptop computers connected either locally or over the Level 1 network. Level 2 controllers, also referred to as local control units shall provide intelligent, stand alone control of HVAC, lighting equipment, and access control. Each unit shall have its own internal RAM memory and will continue to operate all local control functions in the event of a failure to any Level 1 controller. In addition, it shall be able to share information with and from the entire network for full global control.

2. System shall be Trane Tracer SC or approved equal.

J. Communications Processing

1. The BMCS shall operate as a true token-pass peer-to-peer communication network. Resident processors in each Multi-purpose controllers shall provide for full exchange of system data between other Multi-purpose controllers on the high performance peer to peer communications network. Systems that limit data exchange to a defined number of system points are not acceptable.
2. Systems that operate via polled response or other types of protocols that rely on a central processor or similar device to manage interpanel communications may be considered only if a similar device is provided as a stand-by. Upon a failure or malfunction of the primary device, the stand-by shall automatically, without any operator intervention, assume all BMCS network management activities.
3. The failure of any Multi-purpose controller on the network shall not affect the operation of other Multi-purpose controllers. A panel failure shall be annunciated at the specified graphical workstation, alarm printers, or operator terminals.

K. Color Graphic Workstation (located in Custodians Office).

1. The operator workstation will be furnished by the automatic temperature control contractor. The workstation shall consist of the latest generation of PC and shall operate at speed commensurate with the requirements of the ATC graphics and trending requirements. The ATC contractor shall furnish the PC with a dedicated UPS.
2. Network Connection: Graphical workstations shall allow for access to the BMCS network through a pull-down menu approach using only a mouse or similar point device. The keyboard shall be required only when entering text or for programming functions.
    a. The workstation shall be used as an interface to the BMCS network and shall not be required to process any control or energy management algorithms nor manage any BMCS network communications.
3. Graphical Software
    a. Software Description - workstation functions will include monitoring and programming of Level 1 and Level 2 controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments. The workstation software must be able to communicate to all Level 1 and Level 2 controllers, and where necessary integrate information that is common to one or more controllers. It shall be possible to program off-line from any Level 1 or Level 2 controller. The software will be oriented towards operators and programmers. In the operator's mode, all information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system.

All operator functions shall be selectable through a mouse. A "windows" environment shall be used to allow multiple functions to be displayed on the screen simultaneously.

b. Operating System - The software will utilize the IBM's OS/2 Warp multi-user, multi-tasking operating system or equivalent. Provide Microsoft's OS/2 Lan Manager software for operation of the file server.

c. Network Communications - The network consists of a high speed LAN comprised of Level 1 controllers, workstations and a file server. The file server acts as the central database for the workstations, so that all additions or changes made by one operator are immediately available to other operators on the network.

d. System Database - The workstation database shall consist of all points and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including graphic slides, alarm reports, text reports, historical data logs, schedules, and polling records. The software shall conform to the following:

   i. Utilize Microsoft's SQL database server.

   ii. Whenever a new controller is added to the system, the software will automatically update that controller with its assigned points and programs. The system will also be able to verify that the point database in each controller is identical to the one at the workstation. If any discrepancy is found, it will automatically modify its database or notify an operator of the error.

   iii. The database shall also contain host level points consisting of variables which can be used for host level reports and alarming. These variables can be setpoints or the result of any boolean algebra expression.

   iv. Object Tree - It shall possible for an operator view the entire database through a graphical object tree display. This tree will present all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure.

e. System Configuration - Configuration of the database shall be through application modules, each having a unique "icon" for easy visual identification. Each module will provide a windowed menu in which to enter the required data base information. System configuration shall have the following features:

   i. Each site, whether local or remote, shall have a separate record for storing pertinent communication parameters.

   ii. Controllers will be associated with a specific site file. The controller record will also contain the controller passwords and communication logon and logoff text strings.

   iii. Point records will include as a minimum a 32 character point description, engineering units, logging parameters, point status, and point value.

   iv. All database records will be available to the user at all times, regardless of the current tasks being performed by the workstation.

f. Color Graphic Displays - The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units). In addition operators shall be able to

command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

i. SVGA, bit-mapped displays. The user shall have the ability to import CAD-generated picture files in the OS/2 Metafile format as background displays. Updates to imported CAD drawings will not affect workstation added animation.

ii. A library of built in stencils, symbols and display shapes common to the HVAC industry.

iii. An online graphics drawing editor that provides for all standard geometric shapes, multiple line thicknesses, shading, up to 16 colors, cutting and pasting of objects, inclusion of text, and zooming.

iv. Built-in control panel objects such as buttons, knobs, gauges, and line graphs to enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.

v. Status changes or alarm conditions can be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

vi. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators will be able to move from one graphic to another by selecting an object with a mouse, no menus will be required.

vii. The graphic system shall allow for one touch modification of any analog or digital point in the database regardless of its location in the network.

g. Automatic Monitoring - The software shall allow for the collection of data and reports from any Level 1 or Level 2 controller through either a hardwire or modem communication link. The time schedules and content of the polling shall be user configurable and include any subset of the controller's data base including application programs.

h. Alarm Management - The software shall be capable of both accepting alarms directly from Level 1 controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured in the host software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, reports, or initiating communication to another controller or remote computing device. Alarm management features shall include:

i. A minimum of 255 alarm levels. Each alarm level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.

ii. When an alarm occurs the Alarm counter will be incremented by one.

iii. Printout of the alarm or alarm report to an alarm printer or report printer.

iv. Print the alarm acknowledgment or Return to Normal message.

v. Sound an audible beep on alarm initiation or acknowledgment.

vi. It shall be possible to direct alarm displays to all or any of 16 groups of workstations on the network. Each configured path can be assigned on a unique basis to individual alarm levels.

i. Report Generation - The software will contain a built-in report generator, featuring word processing tools for the creation of custom building

reports.

i. Reports can be of any length and contain any points with the database of Level 1 and Level 2 controllers.

ii. The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

iii. It shall be possible to run other executable programs whenever a report is initiated.

iv. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

j. Scheduling - It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.

i. Time of day schedules shall be in a calendar style configured for either monthly or weekly operation. Scheduling shall be programmable up to one year in advance.

ii. Each schedule will appear on the screen as a monthly calendar correctly showing the day, weekday, month and year. It shall be possible to scroll from one month to the next and view or alter any of the schedule times.

iii. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

iv. It shall be possible to configure multiple Holiday schedules in a yearly format. Holiday schedules will override the standard operating schedule for those days that have been defined as holidays. Holidays shall be differentiated on the calendar through color coding of the date. Any changes to a holiday schedule will be automatically updated to the standard schedule to which it has been superimposed.

v. There shall also be a provision for Special Day schedules. Special Day schedules will override both the standard schedule and its associated Holiday schedule. Special Days will be differentiated on the calendar through color -coding of the date. Any changes to a Special Day schedule will be automatically updated to the standard schedule to which it has been superimposed.

vi. The use of Holiday or Special Day schedules is strictly optional. Standard schedules do not require either of these two types of schedules.

vii. The Scheduling application shall include built-in editing tools to permit users to copy and paste portions of schedules to different days, weeks or months. Users can select from a particular day, a range of days, or a nonconsecutive group of days over which to edit a schedule.

k. Programmer's Environment - the programmer's environment will include access to a superset of the same programming language supported in the Level 1 controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software.

l. Security

i. The software shall employ a two tiered password system. The first tier shall consist of the user's name. The second tier shall be a unique password consisting of up to 8 alphanumeric characters.

ii. Each password shall have a unique access level. At least 8 levels will be defined as follows:

◊ No Access - View only graphics as presented in the log-in program.

◊ View Only - View all applications, but perform no database modifications.

◊ Acknowledge Alarms - View Only privileges plus the ability to acknowledge alarms.

◊ Change Values - View and Control point information, Acknowledge Alarms and modify Time Schedules.

◊ Enable / Disable - Change Value level plus allow the enabling or disabling of points and alarms.

◊ Configure - Minimal program level functions including creating and editing any object.

◊ Program - All privileges except password and create users

◊ Administrative - All privileges.

m. Saving/Reloading Programs

i. The workstation software shall have an application to save and restore field controller memory dumps. The site and device record files shall serve as a menu tree to coordinate save/reload records. Each record shall have a minimum 12 character record name and a 32-character description.

ii. The Save/Reload application shall have the capability to set the system clock in a Level 1 controller.

iii. Default values store in the workstation database shall be sent to the controller during a reload operation either automatically or at the user's option.

iv. If during a poll of a controller, the workstation determines that the controller program has been lost, it shall be possible for the workstation to automatically reload the program without operator involvement.

a) The software shall provide, as a minimum, the following functionality:

- Graphical viewing and control of environment
- Scheduling and override of building operations
- Collection and analysis of historical data
- Definition and construction of dynamic color graphics
- Editing, programming, storage and downloading of controller database.

b) The graphical interface shall allow for all system operations and applications to be quickly and easily selected using the mouse in conjunction with groups of drop-down menus, lists, graphics and icons. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device. Provide additional capability that allows at least ten (10) special function keys to perform often-used operations.

c) Software shall provide for a windowed approach which supports concurrent viewing and commanding of system operations. The software shall provide a multi-tasking environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft Windows or similar industry standard software that supports concurrent viewing and controlling of systems operations. The software shall be capable of simultaneously displaying and performing a minimum of two of the functions listed below in any workstation:
   i) Dynamic color graphics and graphic control
   ii) Alarm reporting and acknowledging
   iii) Time-of-day scheduling
   iv) Trend data definition and presentation
   v) Graphic definition
   vi) Graphic construction

d) Graphic displays shall be high-resolution, multi-colored presentations of actual building data and parameters. Graphic displays may be quickly and easily viewed via any or all of the following methods as a minimum:
   - Graphic links
   - Drop down menus
   - Special functions keys for points in alarm
   i) Graphic links shall be standard symbols which can be located on graphic displays as desired by the user. These links shall allow the user to view any graphic display, either in a hierarchical fashion or as otherwise defined. The quantity of possible links shall be limited only by the space available on each display.
   ii) Drop-down menus may be used to view graphic displays by selecting from customized lists which include all graphics available for viewing. Provide the capability to quickly scroll through all lists.

e) Special function keys shall be used to quickly view graphic alarm displays and user-defined default graphics, such as campus or building site plans. From the alarm display, the user may quickly view the graphic on which the associated point in alarm resides.

f) Provide static and dynamic graphic display capabilities. Static displays such as site plans, building layouts, floor plans and schematics shall provide the user with maps to allow for quick and easy access to any building information. Dynamic graphic displays may represent any real-time system information. Any system point or group of points may reside on a dynamic display. Dynamic displays such as schematics of any mechanical system or piece of equipment shall allow the user to monitor and control actual building operating parameters. Point values such as temperature,

humidity and flow, and point status such as on/off, normal and alarm shall automatically and continually update to indicate current operating conditions. As a minimum, symbols, text and colors shall be dynamic in nature.

g) Provide functionality to allow for any analog point value to be displayed as an individual dynamic display window
for use as a convenient control and diagnostic tool. The display window shall include the following information as a minimum:
- Point name
- Point description
- Setpoint
- Current value
- Range of values
- High and low limit setpoints

i) All values shall be displayed in both text and symbolic form, such as an analog bar, gauge or other standard measurement device. Setpoint values shall be changed by simply moving a pointer to the desired setting on the measurement device. After user verification of the correct setting the system shall control at the new setpoint. Provide the capability to superimpose these displays on their associated schematic graphics or on separate displays in user-defined groups.

h) Provide the capability to control any point from a dynamic graphic display. Relevant point information windows may be accessed by pointing to a symbol or text. Setpoints may be changed by simply entering the new value. Status may be changed by selecting from predefined lists. The display shall ask the user to verify the change before allowing the system to respond.

i) Provide alarm annunciation capabilities, such that alarm status shall be displayed automatically on the screen regardless of system operation or application modes. The quantity of current alarms shall be displayed via a flashing icon or similar symbol. In addition, provide an audible signal to indicate the occurrence of new alarms. An alarm window may be displayed to view the alarms. From the alarm window the user shall be able to view the graphic and display a customized message of at least 250 characters associated with the point in alarm. When the graphic id displayed, the symbol of the point in alarm shall be flashing and shall have changed color. The user shall also be able to acknowledge, respond to and clear selected alarm conditions as desired.

j) Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:
- Weekly schedules

- Zone schedules
- Monthly calendars

i) Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on -user-defined days. Equipment scheduling shall be accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

ii) Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all commandable points residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and re-scheduling of points may be accomplished easily via the zone schedule graphic.

iii) Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

k) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point (physical or calculated) may be trended automatically at predetermined time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Any point, regardless of physical location in the network, shall be collected and stored in each DDC controller's point group. Each DDC controller panel shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 70,000 samples.

i) Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least six points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package

such as Lotus 1-2-3 or Microsoft Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

ii) A collection schedule function shall be provided to automatically collect trend data. A menu shall prompt for days of the week and time of day for collection of selected points. Provide a minimum of 12 user-selected time schedules per day.

l) Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and real-time dynamic point data. Up to four points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable. Displays shall include an "X" axis indicating elapsed time and a "Y" axis indicating a range scale in engineering units for each point. The "Y" axis may be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the "Y" axis. All "Y" axis data shall be color-coded to match the line color for the corresponding point.

i) Static graphics shall represent actual point data that has been trended and stored on disk. Exact point value may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.

ii) Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any profit. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the PC disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

m) A full screen, forms based point editor and programming function shall allow for point additions, deletions, changes, program modification and creation and point and program storage. This program shall be similar to a word-processing format such that full documentation of program changes may be available. This program shall provide the user with the capability to insert full English narratives to describe the control program. Search,

insert, find, cut and paste functions shall allow for quick program modifications.

n) Provide a general purpose graphics package such as PC Paint Plus “In-a-Vision” which shall allow the user to quickly and easily define or construct color graphic displays. In addition, provide a library of standard HVAC equipment and symbols such as Rooftop air handling units, chillers, cooling towers and boilers and standard electrical symbols that shall aid the user in definition of standard or custom graphics. Additional libraries of standard symbols may be easily added to the package or the user can define or construct symbols as desired for additional customization. Graphic displays may be defined or created to represent any building parameter, mechanical system or group of system points as described to facilitate building operation and analysis.
   i) Provide the user with the capability to easily define all system operating parameters.
   ii) Libraries of standard application modules such as temperature, humidity and static pressure control may be used as “building blocks” in defining or creating new control sequences.
   iii) The user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format.
   iv) Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters.
   v) The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.

o) Provide the capability to backup and store all system databases on the PC hard disk. In addition, all database changes may be performed while the PC is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate multi-purpose control units. Similarly, changes made at the multi-purpose control units shall be automatically uploaded to the PC, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
   i) The workstation shall provide for automatic upload and download of program changes. Any program change made at the workstation shall be downloaded to the respective multi-purpose control unit. Any program change made at the multi-purpose control unit shall be uploaded to the workstation disk.
   ii) Should a multi-purpose control unit lose its RAM database, the workstation shall automatically download that control unit’s program from the hard disk.
   iii) An auto-boot function shall allow an

unattended workstation to automatically re-start from a power failure.

p) Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

q) Multiple user security levels shall be provided to allow for various degrees of system access and control. Provide a minimum of four levels of access, with each increasing level allowing control of additional system operations and applications. A minimum of twelve unique passwords, including user initials, shall be provided. The system shall automatically generate a report of log-on/log-off time and system activity for each user. Provide automatic log-off capability to prevent unauthorized system use. Automatic log-off time shall be user-definable in one-minute increments and may be disabled if desired.

r) The workstation shall be provided with a key element display that **records** logos, log-offs, TOD overrides, alarms and alarm acknowledgments. Provide a 500 element circular buffer for recording purposes. Key element reports may be filtered by operator name and may be run for a user defined time interval.

n. All points mapped to the workstation shall be available in both text and graphic format. All operator functions available on the text side of the workstation must also be available on the graphics side.

L. Multi-Purpose Controllers

1. Provide multi-purpose DDC controllers. Each multi-purpose controller shall be a microprocessor-based direct digital control unit and shall be capable of operating as a standalone controller on a high performance peer to peer network. Provide each multi-purpose controller with sufficient memory to operate in a truly independent manner; that is, each controller shall support its own inputs and outputs, operating system, database and programs necessary to perform control sequences and energy management routines. Additionally, each multi-purpose controller shall have sufficient memory to support the application specific controllers and LAN control panels connected to it over the local area networks.

2. Each multi-purpose controller shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system. All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.

3. Control strategies shall be owner definable at each multi-purpose controller, and for all control units in the system from any one operator terminal. Each control unit shall provide the ability to support its own operator terminal if so desired.

4. Each multi-purpose controller shall include its own microcomputer direct digital controller, power supply, input/output modules, and battery. The battery shall be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of 100 hours. Upon a power failure at the remote unit, operator intervention shall not be required to maintain the database.

M. Networking Communications

1. General - the network architecture shall consist of two levels. The top level shall be a high speed Ethernet LAN designed to support network controllers, central

plant controllers, work stations and a file server. The second level shall be a RS485 Token passing bus to support a family of dedicated local controllers for control of HVAC equipment, lighting, and access control. The second level bus shall communicate bidirectionally with the high speed LAN through Level 1 controllers for transmission of global data.

2. High Speed LAN - this Ethernet local area network shall operate at a minimum speed of 10 Mb/sec utilizing a TCP/IP communications architecture. The high speed LAN will provide transfer of point data, alarms and file activity among Level 1 controllers, work stations and the file server. The high speed LAN shall support a minimum of 50 nodes consisting of Level 1 controllers or workstations. Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multi-user communications and multi-session activity. That is, all global data sharing shall occur simultaneously with the transmission of alarm data or user activity.
3. Field Bus - the level 2 bus, or field bus, supports local control units of modular size for operation of the building's HVAC, lighting and access control systems. This RS485 bus shall operate at a minimum speed of 19200 baud, with a minimum length
of 4000 feet or 32 nodes before requiring a network repeater. A minimum of 127 Level 2 controllers shall be configureable on the field bus. Manufacturers with baud rates of less than 19200 shall be limited to 64 Level 2 controllers to insure adequate global data and alarm response times.
The field bus shall permit peer to peer communications among all Level 2 controllers and allow simultaneous communications with laptop computers that are connected to a Level 2 controller. Failure of the Level 1 controller will not impair the operation of its associated field bus.
4. Network Transparency - all points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.
5. Workstation Communications - workstations shall be connected directly to the high speed LAN. Workstations shall be able to communicate to any Level 1 controller, Level 2 controller, to additional workstations or the file server. Work stations shall also be able to communicate via modems to remote controllers via a RS232 connection. Telephone communications shall operate simultaneously with communication to any controllers connected on the high speed LAN.
6. Laptop Communications - the laptop computer shall communicate with either Level 1 or Level 2 controllers. Through the laptop, operators shall be able to view points and change parameters on any Level 1 or Level 2 controller on the network.
7. Dial-up Communications - it shall be possible to access the network remotely through a standard dial-up modem. This modem shall permit direct access to the high speed LAN via a Level 1 controller. It shall be possible to configure multiple modems in Level 1 controllers to enable multi-user communications when more than 1 telephone line is available.

N. DDC Controllers:

1. A Level 1 controller has its own on-board CPU, clock/calendar, EPROM, RAM, ROM, communication port(s), and network connections to the high speed LAN and the field bus. The Level 1 controller may either have on-board or remote mounted I/O. Level 1 controllers are capable of complete standalone operation. Level 1 controllers are available with an optional user display.
The firmware shall consist of the operating system, communication software, programming language, and resident control application software. The firmware may optionally contain user interface software to support dumb terminal

operation. Where this is not provided the Level 1 controller must be optionally programmable from the laptop computer. The custom application software shall reside in battery backed RAM or EPROM. RAM will also be used for storing trend data and clock/calendar information.

Level 1 controllers shall provide communication to both the high speed LAN and the field bus. In addition, a minimum of 1 RS232 or RS485 port shall be provided for connection to a workstation or laptop computer. When the port is RS232, it shall optionally support communication to a modem or printer. Where multiple RS232 ports are available, multi-user communications shall be supported.

2. Analog Inputs - the Analog Input (AI) function shall monitor each analog input, perform A/D conversion, and hold the digital value in a buffer for interrogation. The A/D conversion shall have a minimum resolution 12 bits. Input ranges shall be within the range of 0-10 VDC or 4 - 20 mA.
3. Digital Inputs - the Digital Input (DI) function shall accept dry contact closures and voltage level transitions. A voltage level below 1 volt shall be read as ON (closed), a voltage level above 3 volts shall be read as OFF (open).
4. Pulse Accumulator Inputs - the pulse accumulator input function shall have the same characteristics as the DI, except that, in addition a buffer shall be included to totalize pulses between interrogations. Each input shall accept pulses at a minimum of 2 per second.
5. Temperature Inputs - temperature inputs originating from a thermistor, shall be monitored and buffered as an AI, and provide automatic conversion to degrees F or C without any additional signal conditioning.
6. Input Wiring - all inputs shall be two wire devices and shall not require shielded wire for accurate operation.
7. Outputs - output types shall include digital, universal and tri-state. Outputs shall be available with built-in hand-off-auto switches for local overrides.
8. Digital Output - the Digital Output (DO) function shall provide contact closure for momentary (Pulse Width Modulation) and maintained operation of field devices. Output pulse width shall be selectable between 0.1 and 3200 seconds with a minimum resolution of 0.1 seconds. Isolation and protection against voltage surges up to 180 VAC peak shall be provided. Contact rating shall be a minimum of 1 amps at 24 VAC. Each digital output shall be equipped with an optional ON/OFF/AUTO switch to manually obtain either output state. Manual overrides shall be reported to the controller at each update. An LED shall be provided to indicate the state of each digital output.
9. Universal Output - a Universal Output shall provide 0-20VDC, 0-20 mA control signal (with a maximum resolution of .1 volt and .1 mA), and standard Form C relay operation (1 amps, 24 VAC). It shall be possible to select the mode of output operation for each output by simply wiring to the appropriate terminations on the controller. No circuit boards or output cards shall have to be exchanged to select the desired output mode.
10. A three-position manual override switch shall allow selection of the ON, OFF, or AUTO output state. In addition each UO shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.
11. The Form C output mode shall be capable of standard digital output operation including pulse width modulation.
12. All current outputs shall be fuse protected to 120VAC.
13. Tri-State Outputs - tri-state outputs shall consist of two 24VAC relays for control of bi-directional motors and actuators. Each tri-state output is capable of PWM (pulse width modulation) to a resolution of .1 second.

O. DDC Controller Resident Software Features

1. General:
   a. All necessary software to form a complete operating system as described in this specification shall be provided.
   b. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.
2. Control Software Description:
   a. Software Description - The application software shall be configured for each Level 1 controller either locally through a laptop computer or through a workstation. Level 1 controllers shall contain PROM as the resident operating system. Application software will be RAM resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system.
      Each Level 1 controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function by Level 1 controllers shall not be interrupted due to normal user communications including; interrogation, program entry, printout of the program for storage.
   b. Real-Time Operating System - Provide a real time operating system in PROM memory requiring no operator interaction to initiate and commence operations. The program shall include:
      i. Operation and management of all devices.
      ii. Error detection and recovery from arithmetic and logical faults
      iii. Editing software to allow the user to develop or alter application programs.
      iv. System self-testing
      v. Multi-user.
      vi. Multi-tasking.

   c. Editor - When programming a controller through either a dumb terminal or laptop computer, editing and word processing features will include as a minimum:
      i. Cut, copy, paste, and undo.
      ii. Search and replace.
      ii. Comments.
      iv. Scrolling.
      v. Character, line, and page cursor control.
      When programming in terminal mode, the system will allow full screen, character editing for correction or modification of any portion of a program. Syntax errors will be highlighted, and programmers must make corrections prior to the program being compiled. When programming Level 2 controllers, the programming environment will be identical to Level 1 programming with automatic uploading and downloading of the compiled code to the controller.
   d. Point Identification - Users must be able to assign unique identifiers for each connected point. Identifiers must have at least twelve alpha/numeric characters. All references to these points in programs, reports, and command messages shall be by these identifiers.
      Each point name can have up to a 40 character description, and optionally engineering units (up to 8 characters).

e. User Programming Language - The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language and programmable by the user.
The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories.
The language shall allow the creation of timers anywhere in the logic of a program. Each timer shall increment in seconds and increment to a maximum of 365 days.
The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

f. Application Software - The system shall contain include ROM based, built-in software modules for the creation of standard application programs. Modules will include as a minimum:
   i. PID Algorithm
   ii. Self-tuning PID
   iii. Calendar Functions (Seconds, minutes, hour, day of week, day of month, day of year, month and year)
   iv. Curve fit
   v. Optimum Start

g. Mathematical Functions - Each controller shall be capable of performing basic mathematical functions (+,-,X,/), squares, square roots, exponential, logarithms, boolean logic statements, or combinations of both.
The controllers shall be capable of performing complex logical statements including operators such as >,<,=, and,or,exclusive or. These must be able to be used in the same equations with the mathematical operators and nested up to five parenthesis deep.

h. Passwords - Level 1 controllers will have up to 8 levels of passwords. The highest level will allow access to all functions within the system. The remaining 4 levels will be definable by the user to include any subset of system commands.

i. History Logging - Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, and flags) can be logged in history. A maximum of 32767 values can be store in each log. Each log can will record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual.
If shall be possible to find the average of a log, the standard deviation, the sum, minimum or maximum. It shall also be possible to reference any value within a log for use in a control program.

j. Reporting - The system shall be able to create user definable reports containing any combination of text and system variables. Report templates will be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.
Numerical displays shall be up to 10 digits in length, with up to 4 digits to the right of the decimal point. The format of each numerical display shall be user definable.

k. Alarming - For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan and can result in the display of one or more alarm messages or

reports. Messages and reports can be sent to the optional display panel, a local terminal, to the Host Computer, via modem to a remote computing device.

l. Debugging Tools - The language shall have built in program debugging tools for program simulation and error detection.
When a control program is placed in a debug mode, a continuous record shall be kept of the last 128 steps before discarding the oldest data. Up to 4 control programs can be placed in a debug mode concurrently.

m. Overriding Programs - It shall be possible to disable any point in the system and modify it to a user definable value. Any points that have been disabled will be kept in a log and viewable by an operator at any time.

P. Control Valves

1. All automatic valves shall be fully proportioning with packing glands designated for hot or chilled water service. All valve bodies shall be designated for 125 psig service and shall have bronze trim and throttling plug inner valves for modulating control. Valves shall be either normally open or closed and each shall be sized for the allowable pressure drop.
2. All two-way valves shall have external spring adjustment with a self-sealing V-ring packing arranged to tighten the seal as the water pressure increases so that no manual adjustment is necessary.
3. All other heating coil valves shall be either normally open or closed as specified. The interiors of all such valves shall be designed for 100% tight shut-off against the operating pressure.
4. All automatic valves and separable sockets shall be furnished by the Temperature Control Contractor and installed in the lines by the Mechanical Contractor.

Q. Dampers

1. All automatic dampers shall be furnished by this Contractor. Automatic control dampers shall be Ruskin CD60 or approved equal. All dampers for modulating control shall be of the proportioning type with adjacent louvers rotating in opposite directions. Damper frames shall be constructed of 16 gauge galvanized sheet metal. Bearings shall be nylon with oil impregnated sintered iron bushings. All linkages shall be fastened to blades within the damper. Provide double linkages on damper panels over 42” wide.
2. Replaceable rubber seals shall be provided with the dampers. Seals shall be installed along the top, bottom and sides of the frames and along each blade. Seals shall provide a tight closing, low leakage damper. Leakage and floor characteristics charters shall be submitted to the architect prior to approval of dampers.
3. Electronic Actuator
   a. Actuators for damper control shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a “V” bolt design with associated “V” shaped toothed cradle attaching to the shaft for maximum strength eliminating slippages. Spring return actuators shall have a “V” clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
   b. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

c. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
d. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
e. Actuators shall be Belimo, or equal.

4. All of the automatic dampers shall be furnished by the Temperature Control Contractor and installed by the Sheetmetal Subcontractor.
5. Combination smoke/fire control dampers amperage draw of motor shall be provided by temperature control contractor. Dampers shall meet UL555S leakage class 2 standards and shall be equipped with wall sleeves and factory mounted electric actuators. Dampers shall be Ruskin S050 or approved equal.

R. Electronic Sensors
1. All mixed air and coil discharge sensors shall utilize industry standard thermistor with averaging elements. Sensing elements shall be a minimum of 25 ft. and temperature sensed shall be averaged over the entire length of the element.
2. Space type sensors shall have an accuracy of +/-.5 degrees over sensed temperature range (20/120F).
3. Well type sensors used for liquid immersion shall have stainless steel removable wells. Sensing element shall have an accuracy of +/- .5 degrees over amperage draw of motor the range (70/220F or 20/120F) of the sensor. Each sensor shall have a suitable electrical box to enclose all wiring connections.
4. Temperature control wells shall be installed by mechanical contractor under supervision of temperature control contractor.

S. Smoke Detectors
1. The Electrical Contractor shall furnish smoke detectors to be installed in ductwork by the Sheetmetal Subcontractor. The Electrical Contractor shall wire from the detectors to the associated HVAC unit control circuit for shutdown of fans. The Electrical Contractor shall wire the normally closed contacts in series to the fan starter holding coil. All wiring to smoke detectors shall be by the Electrical Contractor.
2. All units shall utilize smoke detectors, as specified.

T. Safety Low Limit Thermostats
1. All fan systems introducing outdoor air with hot water coils shall be equipped with two safety low limit thermostats wired in series designed to stop the fan while closing the outdoor air damper any time the discharge temperature falls below 38 degrees. The safety thermostats shall utilize a 20 foot sensing element responsive to the lowest temperature along its entire length. Provide one thermostat for each 16 square foot coil surface as a minimum.

U. Current Sensors
1. Current sensors shall be analog type, sensitivity dated for the application with a 4-20 ma or 0-10 Vdc output. Span and sensitivity shall be adjustable. Sensors shall be used for all fans and pumps.

V. Air Static Pressure Transmitter
1. Transmitter shall have range of 0-1" or 0.5" w.g. and send a 4-20 milliamp output signal. Zero set range and span set range +/- 5% of full range output. A combined static error (non-linearity, non-repeatability, and hysteresis) +/- .5% of full range output. Transmitter ranges shall be selected by ATC contractor as appropriate for intended use.

W. Water Differential Pressure Transmitter
   1. Low differential pressure transducer for wet-wet application. 4-20 milliamp output signal. Setra C230 or equal.

X. Building Management and Control System Wiring
   1. All input and output control wiring to the control units shall be #18 twisted and shielded cable. All shield to be grounded at the control panel, shields at the sensors or transducers to be folded back and taped.
   2. Communication trunk wiring shall be #18 twisted and shielded cable. Trunk isolator/extenders shall be installed on either end of trunk.
   3. All cable splices shall have joints soldered and taped including the shield. No mechanical connections will be acceptable.
   4. No digital input or output points shall be more than 250 feet from its respective panel.
   5. All wiring within the panels must be made with connectors of appropriate size and design for the terminals being applied.
   6. All connections within the panels must be made with connectors of appropriate size and design for the terminals being applied.
   7. All cables must be labeled and identified on corresponding termination drawings. A copy of the termination drawing will be adequately protected and left in its respective panel.

Y. Control Wiring
   1. Electrical work will be in accordance with NFPA 70, ANSI C2 and Division 16 of these specifications. Electrical wiring, terminal blocks and other high voltage contacts will be fully enclosed and marked to prevent accidental injury.
   2. All wiring associated with the installation will be the responsibility of the Contractor. The term “wiring” is construed to include furnishing of wire, conduit, miscellaneous material and labor to install a total working system.
   3. It is the responsibility of the Electrical Contractor to provide adequate connections and extensions from 120 volt power sources to the various items of equipment requiring power under this contract. Branch circuits serving equipment under this contract will be separate and used only for such equipment. All branch circuit conductors 120 volts or greater will be at least 14 gauge copper, type THW, 600 volt insulation, installed in minimum 3/4 inch conduit (EMT).
   4. Transient Protection - All electronic equipment including processors, relays, monitoring devices, temperature sensors and other non-computerized solid state equipment will be adequately protected against power line transients or RFI interference. Equipment that fails to operate properly due to transient or other electrical interference, in the opinion of the Engineer, will be required to be retrofitted with the appropriate protection device(s).

Z. Points List: (the following points list is the minimum required points that will be available to all user interface devices)
   1. Boilers:
      a. Boiler enable/disable.
      b. Boiler status.
      c. Boiler sequencing.
      d. Boiler firing rate.
      e. Boiler isolation control valves.
      f. Hot water supply temp.
      g. Hot water return temp.
      h. Boiler failure alarms.
      i. Hot water reset control.

2. Boiler pumps:
   a. Pump status.
   b. Lead/lag control.
   c. Differential pressure sensors.
   d. Variable frequency drives % command.
   e. Pump failure alarms.
3. Chillers:
   a. Chiller enable/disable.
   b. Chiller status.
   c. Chilled water supply temp.
   d. Chilled water return temp.
   e. Chiller failure alarms.
   f. Chiller connected load in tons.
   g. Chilled water reset control.
   h. Minimum evaporator chilled water flow control.
   i. Evaporator heater.
4. Chilled water pumps:
   a. Pump status
   b. Pump lead/lag control.
   c. Differential pressure sensors.
   d. Variable frequency drives % command.
   e. Pump failure alarms.
5. Rooftop Energy Recovery Units (ERU):
   a. Unit enable/disable.
   b. Supply fan status.
   c. Supply fan VFD % command.
   d. Return fan status.
   e. Return fan VFD % command.
   f. Discharge air temp. set point (winter)
   g. Discharge air temp. set point (summer)
   h. Discharge static pressure.
   i. Discharge air humidity.
   j. Return air temp.
   k. Return air humidity.
   l. Recirculation air damper command.
   m. Filter status.
   n. Occupied set point.
   o. Unoccupied set point.
   p. Freezestat.
   q. Return air CO2 monitoring (where applicable).
   r. Hot water valve command/position.
   s. Outside air entering temperature. (DB/WB)
   t. Supply air temp. leaving enthalpy wheel. (DB/WB)
   u. Supply air temp. leaving chilled water coil. (DB/WB)
   v. Supply air temp. leaving heat pipe. (DB/WB)
   w. Exhaust air temp. leaving heat pipe. (DB/WB)
   x. Exhaust air temp. leaving enthalpy wheel. (DB/WB)
6. Rooftop air handling units (RTU):
   a. Supply fan status.
   b. Supply fan enable/disable.
   c. Supply fan VFD % command.
   d. Return fan status.
   e. Return fan enable/disable.
   f. Return fan VFD % command.
   g. Discharge air temp.

h. Discharge static pressure.
i. Discharge air humidity.
j. Supply air CFM.
k. Supply air temperature reset.
l. Return air temp.
m. Return air humidity.
n. Return air CFM.
o. Mixed air temp.
p. Mixed air damper command.
q. Outside air CFM.
r. Outside air minimum CFM set point.
s. Filter status.
t. Return air CO2 monitoring (where applicable).
u. Room occupancy sensor (where applicable).
v. Hot water valve command/position.
w. Chilled water valve command/position.

7. Kitchen Make-up Air Unit:
   a. Unit enable/disable.
   b. Fan status.
   c. Fan enable/disable.
   d. Fan Speed Control.
   e. Unoccupied set point.
   f. Kitchen hood exhaust fan interlock.
   g. Return air and outside air damper position command.
   h. Gas furnace staging command.
8. Fancoil Units:
   a. Room temperature.
   b. Room temperature set point.
   c. Occupied set point.
   d. Unoccupied set point.
   e. Chilled/hot water valve command/position.
9. Exhaust Fans:
   a. Exhaust fan enable/disable.
   b. Exhaust fan status.
10. Unit heaters/Cabinet unit heaters:
   a. Room temperature.
   b. Room set point.
   c. Heating valve command.
11. Fintube Radiation and Convectors:
   a. Room temp.
   b. Room set point.
   c. Heating valve command.
12. Radiant Panels:
   a. Room temp.
   b. Room set point.
   c. Heating valve command.
13. Hot Water Heater
   a. Setpoint temperature.
   b. Operational status (on/off)
14. Acid Neutralization System
   a. System failure alarm.
   b. High Level Alarm.
15. IDF/MDF Ductless Split Fancoil Units
   a. High temperature alarm.

b. DFC failure alarm.

16. Global Points:
    a. Outdoor air temp. (DB/WB)
    b. Outdoor air humidity. (Rh)

AA. Hard Wired Alarms

1. The following hard wired alarms shall be provided by the ATC sub-contractor, which shall include a relay output (through a contact closure) and wiring to the MDF room with 30' coiled and labeled at the backer board for connection to the system:
    a. Boiler failure alarm.
    b. ACC-1 failure alarm.
    c. ACC-2 failure alarm.
    d. Hot water pump failure alarm.
    e. Chilled water pump failure alarm.
    f. Building high and low temperature alarm via thermostat monitoring.
2. The access control contractor will take the coiled wire, attach it and program it into the system.

2.52 HOISTING MACHINERY AND EQUIPMENT

A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Filed Subcontractor shall be furnished, installed, operated and maintained in safe conditions by this Filed Subcontractor, as referenced under Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

PART 3 EXECUTION

3.1 MATERIALS AND WORKMANSHIP

A. All materials installed in this work shall be new, unless noted for re-use, without damaged functional or aesthetic components. All equipment finished shall be touched up with matching finishes where slight scratches occur. Equipment or material subject to severe deterioration shall be completely refinished or replaced as directed by the Architect.

B. All labor utilized in the installation of work shall be experienced in the respective trade required. The installation of exposed finished materials shall be neatly done flush, straight and/or plumb, without distortion, meeting the building finished surfaces.

C. All HVAC materials and equipment shall conform to the Standards listed within this Section of the Specifications and wherever such standards have been established, items shall bear its respective label.

D. Where labor to be furnished must meet specific Code requirements, only individuals certified to do such shall be used.

E. All equipment shall be installed in accordance with the manufacturer's instructions and recommendations with adequate clearance for access for maintenance.

3.2 COORDINATION

A. This Contractor shall give full cooperation to other trades and to the General Contractor and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay. If this Contractor installs his work before coordinating with other trades, he shall make the necessary changes in his

work to correct the condition, without extra charge. In areas, if due to construction conditions, more than one trade is required to use common openings in beams, and conduits, this Contractor must plan and locate the positions of the items of piping, ducts, and conduits, which are under the scope of his Contract with that of items under the scope of other Contractors, in order that all items are properly located and may be accommodated within the space available. Location and positioning shall be done prior to installation and to the satisfaction of the Architect and/or Engineer.

B. This Contractor shall obtain detailed printed information from the manufacturer of equipment which he is to provide for the proper methods of installation. He shall also obtain all information from the General Contractor and other Contractors which may be necessary to facilitate his work and the completion of the whole project. All equipment shall be installed in strict accordance with manufacturer's recommendations.

C. The work to be accomplished under this Section includes work within existing areas adjacent to the site of new construction. Continuity of services within existing areas shall be maintained. Any interruption of services necessary to accomplish the work shall be made only with the consent of the General Contractor and at such time(s) as the Owner designates.

D. This Contractor shall not unnecessarily disturb or interfere with the Owner's use of the facilities associated with or adjacent to this Contract. When interference is necessary, permission shall be obtained from the General Contractor before any operation or service line is disturbed or disconnected.

E. This Contractor shall include under coordination work the installation of all systems in conformance with governing codes. This Contractor is advised that no piping, ducts or equipment foreign to the electrical equipment shall be permitted to be installed in, enter or pass through such spaces or rooms provided for switchboards and panelboards in accordance with Article 384 of the National Electrical Code.

F. Diffusers, grilles and registers located in the ceiling shall be located as shown on the Architectural Reflected Ceiling Plan and coordinated with ceiling grid, lights, and speakers. Items shown on the HVAC Drawings, but not located on the Reflected Ceiling Plan shall be coordinated to be located as indicated on the HVAC Drawings.

3.3 COORDINATION DRAWINGS

A. Coordination Drawings shall be initiated under this Section of the Specifications. It is this Contractor's responsibility for preparation of project Coordination Drawings showing the installation of all equipment, piping, ducts and accessories to be provided under this Section of the Specifications. These Drawings shall be prepared at not less than 3/8 inch = 1'0" scale and shall show building room layouts, structural elements, ceiling grid, diffusers, registers, grilles, ductwork and lighting layouts out of function. A reproducible copy of each Drawing prepared shall then be submitted to each Contractor working under the Plumbing, Fire Protection and Electrical Sections of this Specification, who shall be responsible to coordinate their equipment and systems and shall show these on the Drawings submitted. After each Trade Contractor has fulfilled their obligations, they shall return the Drawings to the HVAC Contractor. After each Drawing has been coordinated between trades, each trade shall sign each Drawing indicating acceptance of the installation condition. This Contractor shall then print the coordination original, and these prints shall be submitted, through the General Contractor to the Architect, for review and comment, similar to Shop Drawings. Comments made on these Drawings shall result in a correction and resubmittal of the Drawings. A master small scale Drawing of the entire building shall be initially prepared showing all areas involved and the Drawing numbers

covering each area.

3.4 PROTECTION AND CLEAN UP

A. This Contractor shall be responsible for maintenance and protection of all materials and equipment furnished by him during the construction period from loss, damage or deterioration until final acceptance by the Owner. All materials and equipment on the job site shall be stored and protected from the weather. All piping and equipment openings shall be temporarily closed during construction to prevent obstruction and damage.

B. All equipment with damaged finished surfaces shall be cleaned and repainted with the same paints as were factory applied.

C. Clean-Up: Keep the job site free from the accumulation of waste materials and rubbish daily. At completion of the work, remove all rubbish, construction equipment and surplus materials from the site and leave the premises in a clean condition

3.5 OPERATING AND MAINTENANCE MANUALS

A. This Contractor shall provide four (4) complete sets of operating and maintenance manuals to the Owner prior to the operating instruction period. Maintenance manuals shall be submitted for approval. The receipt of approved maintenance manuals by the Owner shall be a prerequisite to system acceptance. Each manual shall include the following:
   1. A complete set of Shop Drawings arranged in accordance with their appearance in the Specifications. Drawings shall be folded and included in envelopes and bound into the manual.
   2. A complete set of operational and servicing instructions for each piece of equipment, bound into the manual adjacent to the corresponding Shop Drawing.
   3. A complete listing of all equipment suppliers, together with local agent's names, addresses and telephone numbers.
   4. A complete set of valve listings.
   5. Copies of all service contracts provided for the guarantee period.
   6. Copies of all equipment and system warranties.

3.6 OPERATING INSTRUCTIONS

A. This Contractor shall provide competent representatives of his firm and also qualified representatives for his major equipment to instruct Owner-designated personnel on the start-up, operation, shut-down and servicing of all equipment and systems furnished and installed under this Section. No less than ten (10) days' notice shall be given to the Owner for the beginning of the instruction period to permit scheduling of Owner personnel. The instruction period shall be a prerequisite to system acceptance. This contractor shall coordinate this requirement with the Commissioning Agent. Refer to specification section 019100 for additional requirements.

B. Training of the Tenant's and Building Owner's operation and maintenance personnel is required in cooperation with the Tenant's and Building Owner's representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representatives after submission and approval of formal training plans. Refer to Commissioning Specifications, Section 019100 for contractor training requirements.

C. At the conclusion of the operating instructions, this Contractor shall have the Owner's personnel sign-off stating they have received the required instruction. Separate statements shall be required for each piece of equipment and system. These statements shall include date, names of Owner's representative, name of instructor, and brief description of equipment or system.

3.7 SYSTEM START-UP AND OPERATION

A. This Contractor shall provide all labor and materials and services necessary for the initial start-up and operation of all systems and equipment furnished and installed under this Section of the Specifications.

B. This Contractor shall provide the services of qualified factory representatives for all major equipment pre-start set-up, start-up and initial operation. Such periods shall be sufficient to insure proper operation of systems and equipment.

C. This Contractor shall check all equipment during the initial start-up to insure correct rotation, proper lubrication, adequate fluid flows, non-overloading electrical characteristics, proper alignment and minimal vibration. Systems shall be checked for air and/or steam and/or water flows throughout without blockages. Rooftop air handling units shall be checked for proper damper connections and positions aligned and adjusted belt drives, proper lubrication, temporary air filters installed, non-excessive electrical characteristics and minimal vibration. Miscellaneous equipment shall be started and operated as described above, as applicable. This Contractor shall prepare and submit monthly start-up and status reports for all equipment and systems as indicated on the schedules. Initial form of this report shall be submitted for review with the initial submittals. Upon closing in of the structure or upon first equipment start-up, the report filing shall be started. One copy of this report shall be submitted to the Testing and Balancing Contractor for his record purposes. Submittal of these reports is a prerequisite for processing and evaluating requisitions.

1. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specifications, Section 019100 for additional requirements.
2. System verification testing is part f the commissioning process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Commissioning Specification Section 019100 for system verification tests and commissioning requirements.

D. During operation of systems, qualified licensed personnel shall be provided and designated for maintenance of the equipment and systems in good running order. Items such as strainer cleanout, bearing lubrication, packing replacement and other consumables shall be provided without cost to the Owner. Failure of equipment during this period due to lack of proper supervision is the responsibility of this Contractor, and continued failures shall be grounds for the Owner to provide such services with back-charges to this Contractor.

E. Prior to building flush out, all filters installed within all air handling equipment shall be replaced with filters having minimum rating of MERV 13 unless such equipment was specified with filters having a higher rating. Air handling equipment shall include but not be limited to air handling units, rooftop units, energy recovery units, make-up air units, fancoil units and classroom unit ventilators. Upon completion of building flush out, all filters installed within all air handling equipment shall be replaced with filters having minimum rating of MERV 13 unless such equipment was specified with filters having a

higher rating.

F. Coordinate all start-up, operation, and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification section 019110.

3.8 SYSTEMS IDENTIFICATION

A. General:
1. All equipment, ductwork and piping furnished under this Section shall be marked for ease of identification in accordance with ANSI A13.1-1981 Standard or as indicated below by this Contractor.
2. Marking shall be done using painted stenciling applied to clean, smooth surfaces.
3. Lettering type and size shall be in accordance with paragraph 3.4 and Table 3 of ANSI Standard, with sharply contrasted background for ease of identification. Duct labeling shall not be less than 3 inches in height. Colors shall be in accordance with paragraph 3.2 and Table 2 of the ANSI Standard.

B. Equipment:
1. Equipment markings shall be prominently painted on each normally visible side of equipment. Equipment intended for installation in finished areas shall have markings located behind normally used access panels mounted so as to be readily found.
2. Equipment identification designations shall be taken from equipment schedules as indicated on the Drawings.
3. All rooftop air handling units, energy recovery units and make-up air units shall be numbered on at least two (2) sides in 4” to 6” letters of contrasting color. Number shall be associated with the street or occupancy address preceding the HVAC unit number (example, 23-1). LED or keyed remote test switch shall be labeled with device number information corresponding to rooftop designation. Where rooftop units with duct smoke detectors are above a suspended ceiling, the tile grid shall be marked with a red dot if an LED is not present.

C. Piping:
1. Piping marking, except as noted below, shall be prominently painted on all piping concealed and exposed to view, at entries to shafts and at all valving. Marking spacing shall be every 20 feet and at all changes in direction.
2. Piping markings shall indicate direction of flow with piping designation taken from piping legend indicated on Drawings.
3. In lieu of painting pipe marking for outside diameters of no less than 3/4 inches but less than 6 inches labeling shall be on semi-rigid plastic which shall be wrapped entirely around the item being identified and attached to itself to form a non-removable band.
4. In lieu of painting pipe marking for outside diameters of 6 inches or greater, springs or metal bands secured to the corners at each end of the semi-rigid plastic marker so as to hold each end of the marker firmly against the pipe may be utilized.
5. In lieu of painting, for outside diameters less than 3/4 inches, labeling of 1/2 inch high lettering on 1-1/2 inch minimum diameter tags shall be attached so as direction of flow arrows will indicate proper flow direction when tag is being read.

D. Ductwork:
1. Ductwork marking shall be prominently painted on all ductwork concealed and exposed to view. Marking spacing shall be every 20 feet at all dampers and at all changes in direction.

2. Ductwork marking shall indicate direction of air flow with ductwork designation to consist of the equipment designation to which it is connected and indicate either high or low velocity system.
3. Access doors at service openings for fire dampers, smoke dampers and smoke detectors shall be identified with letters no less than 1/2 inch in height to indicate the location of the fire protection device(s) within.

E. Valve Tags:
1. Valve tags shall be 1-1/2 inch diameter brass with 1/4 inch high lettering for service designation over 1/2 inch high valve number designation and shall be provided for all valving.
2. Two (2) sets of valve lists shall be prepared showing tag numbers, valve locations and valve service. Valve tag numbers shall be marked on Record Drawings. One valve list shall be prepared based on sequenced room numbers of valve locations; one valve list shall be prepared based on valve numbers. One set of lists shall be framed under glass and duplicate list laminated between plastic sheets.
3. One (1) additional copy shall be framed under glass and mounted on the wall in location as designated by the Architect.

3.9 SHEET METAL WORK REQUIREMENTS

A. Furnish and install all sheet metal work as herein specified for all air handling systems shown on drawings and/or described in the specifications.

B. All sheet metal work shall be done in a neat and workmanlike manner with ductwork following building lines and in straight lines with smooth transitions and offsets to suit actual installation. Sheet metal work which does not conform to drawings and/or specifications or is poorly done shall be repaired and/or replaced as described by the Architect.

C. Reference shall be made to the paragraph covering Coordination Drawings for the responsibility in the preparation of same.

D. Sheet Metal Contractor shall include in his work furnishing and installing volume dampers in accordance with SMACNA requirements; additional dampers in the duct system for the purpose of balancing by the Balancing Contractor, as well as dampers shown on the drawings.

E. Sheet Metal Contractor include in his work furnishing and installing automatic control, fire, smoke and combination fire/smoke dampers.

F. Air handling systems shall conform to the following:
1. All sheet metal work required for ductwork casing and plenums of all low pressure air handling systems shall be galvanized steel and shall conform to requirements of sheet metal work. Exceptions to this requirement shall be as specifically listed below or as indicated on the drawings.
2. All sheet metal work required for ductwork, casings and plenums of air handling system with scheduled total static pressure equal to or greater than 3 inches shall conform to the requirements for the static pressure scheduled. This construction shall apply from the outside air and return air dampers at the unit

inlet and extend to the system terminal boxes.

3. Sheet metal supply and return ductwork for the surgery areas from the terminal boxes to the supply diffuser (including plenum) and from the exhaust registers for 10 feet shall be aluminum.
4. Sheet metal exhaust ductwork for lab exhaust and all other fumehoods shall be 316 stainless steel. All joints and seams shall be welded to provide a continuous seal.

G. All casings and plenums shall be provided with 54 inch high, 20 inch wide access doors, except where larger door is required for equipment replacement, or when casing or plenum will not accommodate this size door. When alternate door of larger size is required, it shall be sized to meet requirements of equipment being served. For doors smaller than 54" x 20" the largest following door size which can be accommodated shall be provided: 48" x 20"; 36" x 18"; 24" x 18"; 18" x 18"; 18" x 12"; or 12" x 22". In all cases the bottom of the door opening shall be a minimum of 6 inches above the plenum's bottom.

H. Two-piece streamliner shall be furnished and installed at no additional cost to the Owner around each conduit, beam or other obstruction passing through ductwork. Obstructions in ductwork shall be allowed only when offsets around ducts are not possible and shall be indicated on Coordination Drawing.

I. Sealants: All seams in sheet metal work shall be permanently sealed airtight by the use of appropriate mastic compounds. Joints between dissimilar materials shall be provided with lead gaskets. Louver plenums shall be provided with lead gaskets. Louver plenums shall have all bottom seams and side seams up to distance of 12 inches sealed using solder.

J. Duct Liners: Where ducts indicated on drawings or specified are to be lined, such lining shall conform to the requirements specified under Acoustic Liner indicated in Paragraph "Sheet Metal Work". Duct sizes indicated on the drawings are nominal internal dimensions and therefore shall be increased accordingly to accommodate duct lining.

K. The Sheet Metal Contractor shall install all duct mounted smoke detectors, heat detectors and other devices furnished by the Electrical Contractor for mounting in the ductwork or air handling equipment.

L. Fire dampers shall be installed in accordance with the manufacturer's installation instructions. Fire dampers shall be capable of maintaining the integrity of the required fire-resistance rating and shall be accessible. Where ductwork is rearranged to facilitate coordination or installation, the fire dampers shall be provided at locations where air distribution systems penetrate assemblies required to have a fire-resistance rating.

1. Exception when approved by the Architect and Engineer are as follows:
2. When proper fire tests have shown that fire dampers are not necessary to maintain the integrity of the fire-resistance rated assembly.
3. Sub-ducts extending 22 inches vertically upward may be used in lieu of fire dampers for exhaust ducts penetrating a fire-resistance rated shaft wall.
4. Penetrations of tenant separation and corridor walls in buildings equipped throughout with an approved automatic fire suppression system.
5. When the ducts are constructed of steel and are part of an engineered smoke removal system.
6. Penetrations of corridor walls when the ducts are constructed of steel and do not have openings which communicate the corridor with adjacent spaces or rooms.
7. Penetrations of a roof assembly when ducts are open to the atmosphere.
8. Hazardous exhaust systems as defined in the Mechanical Code.

M. All prefabricated duct sections shall be cleaned prior to storage on the site and be

provided with protective covering on all openings to maintain the interior of the ductwork clean and free of dust and other materials prior to installation. Field assembled duct sections shall be cleaned during assembly and similarly protected until installation.

N. Blank off all portions of louvered openings not required for ventilation systems.

O. Access doors shall be provided adjacent to each fire damper, smoke damper, combination fire/smoke damper, and smoke detector. The access opening shall be large enough to permit inspection, maintenance and resetting of the device. Where the size of the duct permits, the minimum size door should be 18 inches x 16 inches.

P. Testing for ductwork shall be performed for all duct systems specified to be constructed to a static pressure class of 4" w.g. or greater and to all stainless steel exhaust systems serving laboratory hoods or other systems designed to convey hazardous fumes or materials. The leakage class shall be in accordance with Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual, First Edition 1985.

R. The Sheet Metal Contractor shall install automatic control dampers furnished by the Automatic Temperature Control System manufacturer and shall include all safing and/or duct transitions to complete damper installation.

3.10 PIPING SYSTEM INSTALLATION

A. Installation of Pipe, Fittings and Valves:
1. Furnish and install piping approximately as indicated; straight, plumb and as direct as possible; form right angles on parallel lines with building walls.
2. Keep pipes close to walls, partitions and ceilings; offset only where necessary to follow walls, as indicated.
3. Locate groups of pipes parallel to each other; space them at distances to permit applying full insulation and to permit access for servicing valves.
4. Piping shall be accurately cut to measurements established in the field and worked into place without springing or forcing. All piping shall be assembled using standard manufacturer's screwed or welded fittings. Where standard fittings are not available for branch connections, use "Threadolets" or "Weldolets" as appropriate to suit pipe sizes, neatly cut and welded into the line.
5. All piping shall be reamed to be free of burrs.
6. Keep pipe free from scale and dirt; protect open pipe ends whenever work is suspended during construction to prevent foreign bodies entering and lodging there. Use temporary plug or other approved material for protection.
7. Use all long radius ells on welded piping.
8. Provide bypass line with globe valve with isolation valves to provide bypass around all control valves which serve air handler coils and other central system equipment. Bypass valves are not required for terminal units, radiation, fancoils, cabinet heaters, unit heaters and similar equipment served from a central system. Bypass valve size shall be a minimum of one-half the supply line size.
9. Prior to installation of any piping, submit shop drawings indicating location of all pipes larger than 2 inches in diameter. Piping may be shown on Coordination Drawings in lieu of shop drawings.
10. Provide cap and chain for 3/4 inch hose connection for all drain valves.

B. Installation for Chilled Water and Hot Water Systems:
1. Pitch all piping in direction of flow.
2. Automatic vent valves shall be installed in the piping systems, where indicated on the drawings or all high points of any piping system.
3. Drain valves shall be located at the base of all low points in the piping systems

and at all water connections to associated equipment and pumps. Drain valves shall be 3/4 inch gate valves with 3/4 inch drain hose threaded adapters.

4. Provide blow-down line with ball valve on each strainer with cap and chain.
5. Provide pressure relief valve and piping to allow bypass of discharge from each pump back to pump inlet where pump shut off head exceeds the maximum rated working pressure of any pipe segment, fitting, valve, or other device. Relief valve shall be sized to recirculate adequate flow to maintain system pressure below the rated working pressure. When provided, the bypass piping shall be connected between the pump and isolation valves.

C. DX Systems:
1. Charging of refrigerant piping shall be done subsequent to pressure testing.
2. Evacuate system to 2.5 mm of mercury and hold vacuum for eight (8) hours and then break vacuum with dry nitrogen. Re-evacuate piping to 2.5 mm and break vacuum with refrigerant charge.
3. Pipe sizing, where indicated on drawings, are the sizes estimated for specific manufacturer's equipment and anticipated piping installation.
   a. The Contractor shall provide piping sized for actual piping installation requirements for the field installation conditions in accordance with the system equipment manufacturer's recommendations.
4. All refrigerant systems which require field piping shall include a filter-dryer, moisture indicator, liquid line sightglass, refrigerant charging connections and solenoid valves. Devices not furnished with the refrigeration equipment shall be provided by this Contractor.

D. Installation of Unions:
1. Provide unions, screwed or flanged, in the following locations:
   a. In long runs of piping to permit convenient disassembly for alterations or repairs. Provide unions in all trench piping located every 20 feet and at all connections in branch and mains leaving the trench.
   b. In bypass around equipment.
   c. In connections to traps, tanks, pumps, and other equipment.

E. Installation of Valves:
1. Provide shut-off valves where indicated and in the following locations:
   a. Risers and main branches at points of take-off from their supply or return mains. Valves shall be arranged so that piping mains for the building and for each floor can remain in service while branch line piping is out of service. Balancing valves suitable for shut-off service shall be used in returned piping.
   b. Individual equipment, control valves, strainers, traps and other piping systems devices at inlet and outlet to permit unit removal for repairs without interfering with remainder of system.
2. Locate valves for easy access and operation.
3. Do not locate valves with stems below horizontal.
4. Provide balancing valve at outlet of each equipment connection. In water piping systems, locate balancing valve as shown on drawings where piping details are provided.

F. Pipe Welding: Welding backing rings shall be used at each pipe weld. All pipe welders shall be tested and qualified under the National Certified Pipe Welders Bureau. Welders for high pressure steam shall be certified for ASME Code welding.

G. Expansion:
1. Provide for taking up expansion in hot water, steam, condenser water and chilled water by means of loops, offsets, guides and anchors, where indicated and/or

required.

2. Use swing or swivel joints for connections from mains to risers and from risers to radiators, unit heaters and other heating units; use at least five (5) fittings from main to riser, including tee in main; use at least four (4) fittings from riser to radiator or unit heater, including tee in riser.
3. When installing expansion loops, they may be cold sprung. Cold springing shall compensate for approximately half of the total expansion.

H. Drains: All coiling coils shall have drip pans, trapped and condensation discharge piped to nearest suitable receptor except as noted otherwise. All traps shall be located inside to prevent freezing. Trap seals shall be appropriate for respective units scheduled pressure differential plus 50 percent on coils downstream of fans, and a minimum 3 inches for coils upstream of fans.

I. Gas Piping: This Contractor shall provide for piping all vent lines to outdoors for the specific type of pressure reducing valves or other gas train devices requiring venting to outdoors under the Gas Codes.

J. Intake and exhaust plenums not detailed to have through-louver drainage shall have a 1 inch drain connection with a serviceable 3 inch deep trap provided within a heated space to prevent freezing and piped to the nearest floor drain or janitor sink. Bottom of plenum shall pitch toward drainage opening. Drain lines indicated on the drawings to terminate through the wall to outdoors shall not be required to include a trap.

3.11 PIPING SYSTEM FLUSHING AND CLEANING

A. This Contractor shall make temporary connections and required adjustments to the piping system for the purpose of cleaning and flushing.

B. Steam and return piping shall be blown out by operating steam with all returns run to waste until the system is thoroughly cleaned out. During the above period, all strainer and thermostatic trap interiors shall be removed and strainers and traps cleaned, together with dirt pockets. The system shall be left free from oil, scale and dirt. The strainer and trap interiors shall be replaced after the system has been cleaned.

C. Hot water and chilled water lines shall be chemically cleaned by circulating water solution for not less than four (4) hours, flushed out and cleaned with water run to waste. All strainers shall be removed, cleaned and replaced. All equipment such as pumps, coils and heat exchangers shall be checked to insure all foreign material has been eliminated. This Contractor shall submit chemical cleaning treatment and method to the Architect for approval.

D. Compressed air lines shall be blown out using compressed air. All filters and instruments shall be removed from system during this flushing and then replaced.

E. Chemical treatment required for cleaning shall be provided a specified under “Chemical Treatment”.

3.12 PIPING SYSTEM PRESSURE TESTS

A. All piping systems furnished and installed under this section shall be pressure and/or vacuum tested prior to being buried, concealed, and/or insulated. This Contractor shall make all necessary temporary connections and gauges required and shall isolate all equipment which may be damaged by testing procedures. This Contractor shall notify

Architect in writing of his testing schedule to permit observation of procedures. Tests shall be initiated only after testing medium has reached ambient temperatures. Systems which fail testing shall be repaired in a manner approved by the Architect and testing repeated. Testing of sections of extensive systems are permitted. Written summary of all testing shall be submitted upon completion of testing indicating system, date of test, testing medium, initial and final pressures and temperatures, repair procedures and supervisor's name.

B. The following systems shall be tested as indicated:

SYSTEM	TEST MEDIUM	TEST PRESSURE PSIG	TIME PERIOD HOURS	ALLOWED DEVIATION PERCENT	NOTES
Hot Water S&R (All)	Water	100	4	0	1
Chilled Water S&R	Water	100	4	0	1
Make-Up Water	Water	90	4	0	1
Chemical Feed	Air	350	4	-5	1
Refrigerant	Nitrogen	250	4	-5	3
Refrigerant	Vacuum	29.5" Hg	4	-5	3

Note 1: Water shall be clean, clear liquid.
Note 2: Compressed air shall be oil-free.
Note 3: Dry nitrogen shall be used for pressure test followed by vacuum test. Introduce refrigerant into piping to break vacuum.
Note 4: Water shall be plant demineralized water.

C. For testing of piping systems exposed to low ambient conditions, this Contractor shall assume responsibility of taking suitable precautions to prevent freezing within piping systems.

D. Fuel oil systems shall be tested in accordance with requirements of applicable requirements of NFPA 30 and NFPA 31 and in accordance with all governing code requirements

3.13 INSULATION APPLICATION REQUIREMENTS

A. Insulation materials shall be installed in accordance with the applicable insulation classes for piping, ductwork and equipment.

B. Insulation shall be applied in a workmanlike manner so as to provide a neat and smooth surface, suitable for painting. Work and/or material that is poorly done or done in a manner not conforming to the specifications and/or drawings shall be repaired or replaced as directed by the Architect.

C. Insulation shall not be applied to piping and related equipment until the completion of pressure testing. Insulation shall not be applied to ductwork and related equipment until air systems have been sealed and/or pressure tested.

D. Sections of piping and equipment may be covered as the work progresses, provided the above requirements have been met for pressure testing and tightness.

E. All piping and equipment to be covered shall be clean and dry prior to the application of insulation.

F. Insulation shall not be applied when ambient temperatures within the space are below 40 degrees F.

G. Piping and duct insulation shall be carried full thickness through all floor and wall openings, except when installed through sleeves through fire-rated construction, insulation shall be discontinued at the penetration and replaced with caulking material specified for sleeves.

H. All insulation shall be applied with edges tightly butted.

I. All voids and/or seams in insulation shall be filled with insulating cement plaster or insulating cement.

J. All insulation ends shall be finished to a 45 degree level with insulation cement troweled to a neat and smooth finish.

K. Equipment nameplates, pressure vessel code labels and equipment access doors shall be left exposed with insulation edges finished as described in Paragraph J. above.

L. Piping installed outdoors with the exception of underground conduit and condenser water piping shall be furnished with layers of insulation of equal thicknesses with the total thickness twice that specified in insulation thickness schedule. The double layer insulation shall be installed so that all seams are staggered. Apply 45 pound roofing felt with 2 inch overlap at joints. All joints to be sealed with asphalt. Wire jacket in place with 16 gauge copper annealed wire on 9 inch centers.

M. Under no circumstances shall pneumatic control tubing be covered with insulation.

N. When installation thickness specified exceeds that provided as manufacturer's standard, then multiple layered material shall be used to achieve specified thickness.

O. Any piping, ductwork or equipment which may convey a fluid gas or air below 75 degrees F. at any time in its normal operation shall be provided with insulation with an external vapor barrier except where explicitly indicated otherwise.

P. Where specified under Pipe Hangers, Supports and Hangers, insulated chilled water, cold make-up water or refrigerant suction lines shall have calcium silicate used at all points of support. Calcium silicate sections shall be of the same thickness as the adjacent insulation with vapor barriers continued unbroken through the support section. Support sections shall be three times the pipe diameter in length or not less than 12 inches nor more than 24 inches. 14 gauge galvanized sheet metal saddles the same length and diameter as the calcium silicate section and covering not less than 120 degrees of arc shall be provided at support points.

Q. Insulated hot water lines shall be provided with welded pipe saddles at all support points. Saddles shall fit the insulation outside diameter with insulation filling the void between pipe and saddle.

R. All chilled water, cold make-up water or other piping insulation with vapor barriers shall not be stapled. Sections of insulation which are stapled shall be removed and replaced with new material as specified.

S. Insulation for piping and equipment shall be provided with wire or band supports to prevent sagging and cracking of finished surface or vapor barrier. Supports shall be applied in accordance with insulation manufacturer's recommendations. Supports shall generally be located beneath finish jacketing.

T. Valves which are specified to be insulated shall be covered to top of bonnets.

U. Insulation for piping systems shall be provided up to coil connections and the exterior casing, including tube returns or manifolds external to casing shall also be insulated except where noted otherwise.

V. Engine exhaust pipes, fittings, and silencers shall be covered with 4 inch calcium silicate insulation. Insulation shall be applied in two (2) layers with staggered joints. Secure insulation in place with heavy gauge stainless steel bands. Seal all seams and joints in each layer with high temperature cement. Cover insulation with reinforced glass fiber cloth.

W. All unlined supply and return ductwork located outdoors shall have a minimum thickness of 2 inches of rigid board insulation and an aluminum weatherproof cover applied over the vapor barrier.

3.14 SYSTEM BALANCING

A. This Contractor, as part of his contract, shall obtain the services of a testing and balancing agency that specializes in this type of work, to perform the work required under this section.
   1. The testing and balancing agency selected shall not have installed, fabricated or engineered any part of the system that the testing and balancing work shall be performed on, so as to prevent any conflict of interest. This shall include but not be limited to drilling and patching holes, taking apart and re-assembling equipment, removing and replacing fan guards, removing and replacing control box covers, and changing belts and sheaves.
   2. In addition, the selected company shall not be a subsidiary of or be associated with persons having financial interests in the accessories, ductwork, and controls, undergoing these tests so that the Owner will receive a completely unbiased test and balance report upon completion of the work.
   3. Additionally, the testing and balancing agency shall complete no work on the HVAC systems, where such work involves the installation or modification to the HVAC systems. Such work is solely assigned to the HVAC sub-contractor and their employees. Note that it is the intention of the paragraphs herein to assign full responsibility for labor, tools, corrections, installation of balancing dampers, installation or test openings, pullet changes, belt changes, and all other "work", which involves modifications or corrections to the HVAC system to HVAC sub-contractor. Where the testing and balancing agent is assigned "work" herein, such work shall be limited to testing, reporting, and providing sufficient information to the HVAC sub-contractor such that they can make necessary modifications or corrections for proper system operation.

B. The selected testing and balancing agency shall be a certified member of the AABC or the NEBB. Minimum criteria for this project shall be the General Membership Standards of the Associated Air Balance Council, as published nationally in AABC NSFMI Volume One, #81266 or as otherwise noted herein.

C. All work performed by the approved agency shall be done in full accordance with minimum standards as set forth in AABC National Standards, Fourth Edition (1982) and

ASHRAE Systems Manual (1984). In addition, vibration readings shall be taken on all rotating equipment in this section and recorded in mills of deflection.

D. Submittals:
1. The TAB Agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's Test and Balance Engineer (TBE) certificate.
2. The TAB Agency shall submit the TAB procedures and agenda proposed to be used.
3. The TAB Agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

E. This Contractor shall cooperate with the test and balance agency in the following manner:
1. Provide sufficient time before final acceptance data so that tests and balancing can be accomplished and reviewed.
2. Provide immediate labor and tools to make corrections when required without undue delay. Install balancing dampers where required by the test and balance agency.
3. Put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.
4. The testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with four (4) complete sets of Construction and Coordination drawings, one (1) set of which shall be turned over to the Owner with ductwork systems differentiated by coloring each system's ductwork in a distinguishing color and diffusers, registers and grilles identified with a number corresponding with the respective item on the balancing report.
5. Include the costs of test openings, dampers, pulley and belt changes in his contract.

F. The test and balance agency shall test and balance all air handling systems and equipment and shall also test and balance all hot water and make-up water systems. All systems shall be adjusted so that they achieve within 10 percent of design quantities, except over-all pressure relationship shall be maintained.
1. Where provided, air flow measuring devices shall be utilized to balance air system. Accuracy also shall be verified by the balancing agency.
2. Final adjustments to each variable volume and constant volume box shall be provided by the balancing agency.
3. Where combination balancing valve and flow measuring devices, or flow devices, are indicated, the balancing agency shall utilize them for balancing the water system.

G. The items requiring testing, adjusting and balancing include the following:
1. Air Systems:
   a. Supply Fan AHU's
   b. Return Fans
   c. Exhaust Fans
   d. Zone Branch and Main Ducts
   e. VAV Systems
   f. Diffusers, Registers and Grilles
   g. Coils (Air Temperature)
   h. Induction Units

2. Hydronic Systems:
   a. Pumps
   b. System Mains and Branches
   c. Boilers
   d. Coils

H. TAB Preparation and Coordination:
1. Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to start of TAB work.
2. System installation and equipment start-up shall be complete prior to the TAB agency's being notified to begin.
3. The building control system shall be complete and operational. The Building Control System Contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided for reprogramming, coordination, and problem resolution.
4. All test points, balancing devices, and identification tags shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
5. Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided for coordination and problem resolution.

I. Reports:
1. The TAB agency shall submit the final TAB report for review by the Engineer. All outlets, devices, and HVAC equipment shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.
2. Submit four (4) copies of the final TAB Report.

J. Deficiencies:
1. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.
2. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.
3. System balance reports which, upon field inspection of the systems, are found to be erroneous, shall have the questioned systems corrected by the test and balance agency until a proper balance is achieved. Such correction work shall be done at no cost to the Owner. Balancing Contractor shall field verify balancing settings and measurements as randomly selected by the Architect.

K. All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

L. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or – 10% unless otherwise stated.
1. Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be

marked to show final settings.

2. All information necessary to complete a proper TAB project and report shall be per AABC Standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.

M. Air Systems:

1. The TAB agency shall verify that all ductwork, dampers, grilles, registers and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards.
2. For Supply Fans:
   a. Test and adjust fan RPM to achieve maximum or design CFM.
   b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
   c. Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM.
   d. Test and adjust the outside air on applicable equipment using a pitot-tube traverse. If a traverse is not practical use the mixed air temperature method if the inside and outside temperature difference is at least 20 degrees F. or use the difference between pitot-tube traverses of the supply and return air ducts.
   e. Test and record system static profile of each supply fan.
3. For Return Fans:
   a. Test and adjust fan RPM to achieve maximum or design CFM.
   b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
   c. Perform a pitot-tube traverse of the main return ducts to obtain total CFM.
   d. Test and record system static profile of each return fan.
4. For Exhaust Fans:
   a. Test and adjust fan RPM to achieve maximum or design CFM.
   b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
   c. Perform a pitot-tube traverse of main exhaust ducts to obtain total CFM.
   d. Test and record system static profile of each exhaust fan.
5. The Balancing Contractor shall make all necessary tests and measurements and provide information to provide for replacement of adjustable sheaves utilized for initial balancing with optimum sized fixed sheave and select optimum replacement sheave sizes for existing equipment fan drives for systems indicated to be modified. All adjustable sheaves replaced shall be tagged to indicate which unit it was on and turned over to the Owner.
6. For Zone, Branch and Main Ducts:
   a. Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
7. For VAV Systems:
   a. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements.
   b. Identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.

8. For Diffusers, Registers and Grilles:
   a. Test, adjust and balance each diffuser, grille and register to within 10% of design requirements. Minimize drafts.
   b. Identify the type, location, and size of each grille, diffuser and register. This information shall be recorded on air outlet data sheets.
9. For Coils:
   a. Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperature shall be taken on the entering and leaving side of each coil.
10. Where air balancing can not be completed due to lack of air flow and the reason for the lack of air flow can not be identified, a static profile shall be performed to identify the reason for loss of adequate air flow.

N. Hydronic Systems:
1. The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards.
2. For Pumps:
   a. Test and adjust hot water pumps to achieve maximum or design GPM. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead Head calculations.
   b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.
3. For System Mains and Branches:
   a. Adjust water flow in pipes to achieve maximum or design GPM.
4. For Boilers:
   a. Verify that boilers have been filled and started by others, and are in operation.
   b. As applicable, test and record motor voltage and amperage, and compare data with the nameplate and limits to ensure motor is not in or above the service factor.
   c. Test and adjust water flow through water boilers.
   d. Test and record temperature and pressure profiles of water boilers.
5. For Coils:
   a. Test, adjust and balance all chilled water and hot water coils within 10% of design requirements.
   b. Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

O. The TAB agency shall conduct sound testing in the following areas per AABC National Standards and to the criteria listed, using sound meter with octave band analyzer:
1.

Test Area	Number of Locations	NC Level Acceptable
General Office	16	30-35
Computer/Equipment Rooms	4	40-45
Schools/Classrooms	16	25-30

P. The TAB agency shall conduct vibration testing on the following equipment per AABC

National Standards. Test deflection in mils and velocity in inches per second shall be measured and the results compared to requirements in equipment specification sections.

1. EQUIPMENT
   Fans over 3.0 Horsepower
   Pumps over 3.0 Horsepower

Q. Indoor Air Quality Verification:
   1. The TAB agency shall take measurements at design outside air. It shall measure temperature and humidity uniformity throughout the space, check filter installation for proper fit, seal, and operation and verify condensate drain operation. The TAB agency shall note any water damage or obvious contamination sources from inside or outside.
   2. The TAB agency shall conduct the following air sampling tests for every 2,500 square feet of space:
      a. Carbon Dioxide
      b. Carbon Monoxide
      c. Ozone
      d. Nitrogen Oxides
      e. Formaldehyde
   3. The TAB agency shall prepare a report showing the results, location, time and date of each test. A summary of the HVAC operating conditions, and a listing of any discrepancies shall be provided.
   4. All IAQ readings are applicable only to the date and time noted in 3.06C.

R. The TAB agency shall review the project documents and Contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.

S. During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are performed when 60% of the total system is installed and again when 90% of the total system is installed, prior to insulation of the duct and piping.) The TAB agency shall submit a written report of each inspection.

T. The Installing Contractor shall isolate and seal sections of ductwork for testing. The test pressures required and the amount of duct to be tested shall be described by the Engineer in the appropriate duct classification section. All testing shall be based on one test per section only unless otherwise noted.

U. The TAB agency shall be assisted by the Building Control Systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems.
   1. Automatic Temperature Control Contractor shall have all automatic valves adjusted and calibrated prior to balancing.
   2. The Balancing Contractor shall make all necessary tests and measurements and provide information by the Automatic Temperature Control Contractor to select the optimum range of sensing and control devices.
   3. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freezestats, and other safety devices.
   4. Verify that all controlling instruments are calibrated and set for design operating

conditions.

V. To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees F. from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

W. At the time of final inspection, the TAB agency may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

X. The TAB agency shall test and adjust fume hood total air flow by duct pitot-tube traverse. If a pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Test and record face velocities under design operating conditions using a maximum of a one square foot grid pattern across the entire open face. The TAB agency shall set sash height on hoods to obtain face velocities within 20% of 100 feet per minute unless specified otherwise. It shall test and adjust VAV controllers to obtain design exhaust air flows and make-up air flows to maintain design hood pressures and face velocities, and design room pressurization. The TAB agency shall test for turbulence and proper air flow patterns at the face and inside the hoods using a hand-held smoke puffer or other approved smoke-emitting device.

Y. The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

Z. The TAB agency shall test and record life safety control operation on the HVAC equipment. It shall verify the installation of required smoke detectors in air handling equipment (AHE), and shall verify operation of the smoke detector by activating the smoke detector and observing air handler shut-down. With the controls and alarm contractors, the TAB agency shall verify the operation of interconnected systems such as the AHE smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequences.

END OF SECTION

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SECTION 26 00 00
ELECTRICAL

INDEX

PART 1 GENERAL....1
1.1 GENERAL PROVISIONS....1
1.2 GENERAL REFERENCES....1
1.3 SCOPE OF WORK....1
1.4 RELATED WORK SPECIFIED ELSEWHERE....2
1.5 DEFINITIONS....2
1.6 EXAMINATION OF SITE AND CONTRACT DOCUMENTS....3
1.7 RECORD DRAWINGS....3
1.8 SHOP DRAWINGS....3
1.9 MOCK-UPS....4
1.10 CODES, REGULATIONS AND PERMITS....4
1.11 INTENT....5
1.12 DRAWINGS AND SPECIFICATIONS....5
1.13 GIVING INFORMATION....5
1.14 OBTAINING INFORMATION....5
1.15 MATERIALS AND EQUIPMENT....6
1.16 ELECTRICAL CHARACTERISTICS....6
1.17 TEMPORARY LIGHT AND POWER....6
1.18 OPERATIONS AND MAINTENANCE MANUALS....6
1.19 GUARANTEE AND SERVICE....7
1.20 DEBRIS REMOVAL AND CLEAN-UP....7
1.21 COMMISSIONING REQUIREMENTS....7
PART 2 PRODUCTS....7
2.1 NAMEPLATES....7
2.2 ELECTRICAL SWITCHBOARD....8
2.3 PANELBOARDS....9
2.4 PULL BOXES, JUNCTION BOXES AND WIREWAYS....10
2.5 OUTLET BOXES AND ACCESSORIES....11
2.6 CONDUIT....11
2.7 WIRE AND CABLE....12
2.8 WIRING DEVICES....13
2.9 WIRING DEVICE PLATES....14
2.10 LIGHTING FIXTURES....15
2.11 ELECTRICAL SUPPORTING DEVICES....17
2.12 DISCONNECT SWITCHES....17
2.13 FUSES....17
2.14 STARTERS....20
2.15 THERMAL SWITCHES....21
2.16 ACCESS PANELS....21
2.17 DRY TYPE TRANSFORMERS....21
2.18 EMERGENCY STANDBY SYSTEM....22
2.19 TIME CLOCKS....29
2.20 FIRE ALARM SYSTEM....30
2.21 PUBLIC SAFETY SIGNAL BOOSTER SYSTEM....46
2.22 ELECTRONIC SAFETY AND SECURITY....48
2.23 CABLE TRAY....48
2.24 SCOREBOARDS....49
2.25 DRY TYPE K-RATED TRANSFORMERS....51
2.26 LIGHTNING PROTECTION....54

2.27 COMMUNICATIONS SYSTEM....57
2.28 ZERO SEQUENCE HARMONIC FILTERS....57
2.29 LIGHTING CONTROL SYSTEM....60
2.30 SURGE PROTECTIVE DEVICES (SPD's)....75
2.31 THEATRE AND STAGE EQUIPMENT....81
2.32 SHORT CIRCUIT/COORDINATION/SELECTIVE COORDINATION STUDY....81
2.33 MINERAL INSULATED METAL SHEATHED CABLE (MI CABLE)....83
2.34 FANS (DESTRATIFICATION)....86
PART 3 EXECUTION....88
3.1 INSTALLATION REQUIREMENTS....88
3.2 CLEANING, ADJUSTING AND TESTING....88
3.3 SLEEVES, INSERTS AND SUPPORTS....89
3.4 EQUIPMENT CONNECTIONS....89
3.5 MOTOR AND CONTROL WIRING....89
3.6 HVAC WIRING....90
3.7 CONCRETE WORK....90
3.8 GROUNDING....90
3.9 CONDUIT WORK....91
3.10 WIRE AND CABLE....92
3.11 INSTALLATION OF OUTLETS....93
3.12 EXTERNAL TELEPHONE SERVICE....94
3.13 EXTERNAL CABLE TV SERVICE....94
3.14 ELECTRIC SERVICE....94
3.15 UNDERGROUND DUCTBANK....95
3.16 FIRE STOPPING....97
3.17 SPECIAL COORDINATION INSTRUCTIONS....97
END OF SECTION....98

SECTION 26 00 00
ELECTRICAL
(Filed Sub-Bid Required as Part of Section 26 00 01)

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 – General Requirements.

1. Work of this Filed Sub-Bid includes all individual Specification Sections listed in Section 26 00 01.

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Conditions Contract for Construction Services and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. The scope of work consists of the installation of all materials to be furnished under this Section, and without limiting the generality thereof, consists of furnishing all labor, materials, equipment, plant, transportation, rigging, staging, appurtenances and services necessary and/or incidental to properly complete all electrical work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either, in the opinion of the Architect as being required.

B. The work of this Section includes:
1. Primary Electric Service.
2. Secondary Electric Service and Metering.
3. Switchboard.
4. Grounding.
5. Sleeves, Inserts and Openings.
6. Pullboxes, Junction Boxes and Wireways.
7. Panelboards.
8. Dry-type Transformers.
9. K-rated Transformers.
10. Conduit.
11. Wire and Cable.
12. Electrical Supporting Devices.
13. Outlet Boxes and Accessories.
14. Wiring Devices and Plates.
14. Floor Outlets.
16. Lighting Fixtures and Lamps.
17. Starters.
18. Disconnect Switches.
19. Emergency Standby System.
20. Fire Alarm System.
21. Public Safety Signal Booster System.
22. Zero Sequence Harmonic Filters.

23. Lightning Protection System.
24. Building preparation for Communications System, Specifications Sections 27 10 00, 27 21 33, 27 40 00, 27 50 00 and 27 70 00.
25. Building preparation for Electronic Safety and Security Systems, Specifications Sections 28 00 00.
26. Surge Protective Devices (SPD'S)
27. Cable Tray and Accessories.
28. Lighting Control System.
29. Nameplates.
30. Fuses.
31. Thermal Switches.
32. Access Panels.
33. Timeclocks.
34. Scoreboards.
35. Installation of Theatrical Lighting Equipment as furnished by Section 11 61 11 and wiring and conduit to connect Theatrical Lighting Equipment and Building preparation as indicated on Drawings.
36. Short Circuit/Coordination/Selective Coordination Study.
37. Mineral Insulated Metal – Sheathed System (MI Cable).
38. Destratification Fans.

C. The Electrical Subcontractor shall be responsible for all cutting related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade effected.
   1. For coordination of cutting and patching refer to Section 01 31 00, Project Management and Coordination.
   2. For cutting and patching Specifications, refer to Section 01 73 00, Execution.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. The following related work or material shall be provided under the designated Divisions:
   1. Excavation, backfill, pumping, and shoring: Division 31, "Earthwork."
   2. Concrete work: Division 03, "Concrete."
   3. Flashing and counterflashing for all roof openings: Division 07, "Thermal and Moisture Protection."
   4. Field Painting: Division 09, "Finishes."
   5. Specialty Equipment: Division 11, "Equipment."
   6. Elevator: Division 14, "Conveying Systems."
   7. Sprinkler System: Section 21 00 00, "Fire Suppression."
   8. Plumbing Equipment: Section 22 00 00, "Plumbing."
   9. HVAC Equipment: Section 23 00 00, "HVAC."
   10. Door Hardware: Section 08 71 10.
   11. For restrictions concerning the hanging of materials, piping, mounts, brackets, hangers, hooks and other items from metal decking. Steel Decking, Section 05 31 00.

1.5 DEFINITIONS

A. "E.C." or "Contractor" as used herein after in this Section shall mean the "Electrical Subcontractor," i.e., the filed bid subcontractor under this Section 26 00 00.

B. "Concealed" shall be defined as areas where conduit and wiring is located in chases, walls, partitions, shafts, and above finished ceilings.

C. "Underground" shall mean conduit and wiring exterior to or within the Building that is buried. All other conduit and wiring shall be considered "exposed."

D. "Exposed" shall mean conduit and wiring run on the surface of the Building construction.

E. "Conduit" shall mean in addition to conduit, all fittings, hangers and other accessories relating to such conduit systems.

F. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

1.6 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Bidders are advised to visit the site and inform themselves as to conditions under which this work will be performed. Failure to do so will, in no way, relieve the successful bidder from the responsibility of furnishing any materials or performing any work in accordance with the true intent and meaning of the Drawings and Specifications.

B. No claim for extra compensation will be recognized if difficulties are encountered which an examination of the site conditions and contract documents prior to executing the contract would have revealed.

C. The Electrical Subcontractor shall be responsible for ordering and furnishing the correct quantity of material required. Routing and equipment arrangements shown on the Drawings are approximate only and are not warranted to be accurate.

D. Arrangements shall be made with the Owner prior to the visit for inspection of the existing Buildings.

1.7 RECORD DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 78 00, Closeout Submittals for Requirements.

B. The Record Drawings required to be furnished under this Section are of the "E", "T", "TAV", "TL" and "TR" Series Drawings.

1.8 SHOP DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 33 00, Submittal Procedures, for submittal provisions and procedures.

B. In accordance with Division 1, General Requirements, submit to the Architect for approval complete sets of detailed information consisting of manufacturer's' bulletins, capacities, Shop Drawings, and parts lists of all material to be provided for this project.

C. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and

appearance required. This is NOT a proprietary Specification unless otherwise noted and it should be noted that or approved equal applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product Specifications and such minor variations shall not eliminate such manufacturers as an approved equal. It is the intent of this Specification to encourage open and competitive involvement from multiple manufacturer's that are able to supply similar products.

1.9 MOCK-UPS

A. General: Refer to Division 1, General Requirements, Section 01 43 29, Mock-Ups for requirements.

B. The Electrical Subcontractor will be required to mock-up (1) typical classroom and (1) typical science classroom as described in Section 01 43 29.

1.10 CODES, REGULATIONS AND PERMITS

A. All work done under this Section shall conform to the Codes and regulations governing such work as follows:
1. ANSI American National Standards Institution
2. ASTM American Society for Testing Materials
3. CS Commercial Standards
4. FS Federal Specifications
5. IEEE Institute of Electrical and Electronic Engineers
6. IES Illuminating Engineering Society
7. NEC National Electrical Code
8. Massachusetts Electrical Code
9. NECA National Electrical Subcontractors Association
10. NEMA National Electrical Manufacturer's Association
11. NFPA National Fire Protection Association
12. UL Underwriters Laboratory
13. NESC National Electrical Safety Code
14. IPCEA Insulated Power Cable Engineers Association
15. EEI Edison Electrical Institute
16. EIA Electronic Industry Association
17. All Local Governing Codes.

B. Give notices, file plans, obtain and pay for permits and licenses and obtain necessary approvals from authorities having jurisdiction. Permits shall be secured through the City. Deliver certificates of inspection to Architect. No work shall be covered before examination and approval by Architect, inspectors and authorities having jurisdiction. Imperfect or condemned work shall be replaced with work conforming to requirements, without extra cost to Owner, subject to the approval of the Architect. If work is covered before due inspection and approval, the Electrical Subcontractor shall pay costs of uncovering the installed work, whether it meets contract requirements or not. Refer to Section 00 21 13 Instruction to Bidders and General Conditions Contract for Construction Services for payment of fees.

1.11 INTENT

A. It is not intended that the Drawings show every conduit, fitting and appurtenance. All such parts necessary for the complete execution of the work, in accordance with the best practices of the trade and to the satisfaction of the Architect shall be provided whether these parts may have been specifically mentioned or not, or indicated on the Drawings.

1.12 DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are complementary each to the other, and any labor or material called for by either, whether or not by both, or necessary for the successful operation of any components shall be furnished and installed.

B. Before installing any work, verify that it does not interfere with the clearances required for other work. Installed work which interferes with existing necessary services shall be modified as directed by the Architect, at no additional cost to the Owner.

C. Be familiar with the Drawings and Specifications of all other trades to prevent interferences and assure complete coordination.

1.13 GIVING INFORMATION

A. Keep fully informed as to the shape, size and position of all openings and foundations required for all apparatus furnished under this Section and give full information to the General Contractor sufficiently in advance of the work, so that all such openings and foundations may be built in advance. Furnish all sleeves and supports herein specified, so the General Contractor may install same in place.

B. In the case of failure to give proper information as noted above, assume the cost of having necessary changes to the work made by the General Contractor.

1.14 OBTAINING INFORMATION

A. Obtain detailed information from the manufacturers of apparatus which is to be provided, for the proper methods of installation. Obtain all information from the General Contractor and other Subcontractors which may be necessary to facilitate the work and the completion of the whole project.

B. Electrical Subcontractor shall inspect the site associated with this project prior to submitting his bid and shall investigate all conditions under which this work will be performed. This shall include determination of exact locations of items indicated as existing on the Drawings. Such existing locations are diagrammatic and shall not be construed as exact enough to use for equipment and labor estimating purposes. Failure to inspect existing conditions or to fully understand the work which is required shall not excuse the Electrical Subcontractor from his obligation to supply and install work in accordance with the Specifications and Drawings and under all existing site conditions. It shall be the responsibility of the Electrical Subcontractor to investigate and locate all existing underground utilities which may conflict with the installation of this electrical work. Coordinate elevations of conduits required to be installed under this Contract to avoid

interference with any existing underground utilities.

1.15 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished under this Section shall be new and of the best grade for the service intended. The manufacturers mentioned in the Specifications are intended to indicate the quality desired. Any substitutions shall be approved by the Architect as herein provided by the “or equal” clause, in addition to meeting the limitations of space and capacity shown or specified. Re-built materials and equipment will not be accepted.

1.16 ELECTRICAL CHARACTERISTICS

A. In general, and unless specifically indicated otherwise in the Specifications or noted on the Drawings, all new Building service, heating, ventilating, air conditioning and plumbing equipment shall be of the following characteristics:
   1. Motors up to and including 1/3 HP shall be suitable for 120 volt, single phase operation.
   2. Motors larger than 1/3 HP shall be suitable for 480 volt, three phase operation.

1.17 TEMPORARY LIGHT AND POWER

A. Provide capacity the local utility company power lines, make arrangements with the local utility company for temporary service and pay all expenses related thereto.

B. Refer to Division 1, Section 01 50 00 for requirements.

1.18 OPERATIONS AND MAINTENANCE MANUALS

A. At least two (2) months prior to the time of turning over this contract to the Owner for use and occupancy or substantial completion, secure and deliver to the Architect three (3) complete indexed files containing approved operating and maintenance manuals, Shop Drawings and other data as follows:
   1. Operation description of all systems.
   2. Complete Shop Drawings of all equipment.
   3. Preventive maintenance instructions for all systems.
   4. Spare parts lists of all system components.
   5. Names, addresses and telephone numbers of all suppliers of the systems.

B. Non-availability of operating and maintenance manuals or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the Owner until such time as the discrepancy has been corrected and/or retainage of sufficient monies to prepare same.

C. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner's operating and maintenance personnel in the proper operation and maintenance of the systems. Instruction period shall be five (5) eight-hour days.
   1. Training of the Tenant’s and Building Owner’s operation and maintenance personnel is required in cooperation with the Tenant’s and

Building Owner's Representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representative after submission and approval of formal training plans. Refer to Commissioning Specification, Section 01 91 00, for Electrical Subcontractor training requirements.

1.19 GUARANTEE AND SERVICE

A. The Electrical Subcontractor shall guarantee the performance of the installation and all equipment included in this Section in writing for one year from the date of final acceptance of same. Should any defects in materials or workmanship appear during this period, they shall be corrected or replaced by the Electrical Subcontractor to the satisfaction of the Architect, and at no additional expense to the Owner.

1.20 DEBRIS REMOVAL AND CLEAN-UP

A. The Electrical Subcontractor shall, at the end of each day's work, remove waste materials and debris resulting from the installation of the electrical system. The Electrical Subcontractor shall deposit such waste and debris in a dumpster on-site. Dumpster shall be provided by the General Contractor. The General Contractor shall be responsible for the emptying of dumpster when required.

B. The Electrical Subcontractor shall, at the completion of his work, remove from the property all tools, equipment and surplus materials resulting from the installation of the electrical system.

1.21 COMMISSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. The Electrical Subcontractor shall assist and support the CA as necessary in accordance with the requirements of Specification Section 01 91 13 – Commissioning Requirements/Plan.

1. Commissioning of a system or systems specified in this Section is part of the construction process. Documentation and testing of these systems, as well as training of the Tenant's and Building Owner's operation and maintenance personnel, is required in cooperation with Tenant's and Building Owner's Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Requirements/Plan, Section 01 91 13, for detailed commissioning requirements.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be furnished and installed on the switchboard and switchboard circuit breakers, panelboards, dry-type transformers, junction boxes, cabinets for

all special purpose switches, motor disconnect switches, starters and other controls furnished under this Contract, to designate the equipment controlled and function.

B. Nameplates shall be laminated white bakelite with 1/4" high black recessed letters. Nameplates shall be securely attached to the equipment with galvanized screws or rivets. Adhesives or cements will not be permitted.

C. Power branch circuit junction boxes shall be identified with circuit's panel(s) orgin and circuit number(s) by means of black fibre pen.

D. All pull boxes and junction boxes shall be identified as to system and function by means of black fibre pen.

2.2 ELECTRICAL SWITCHBOARD

A. Furnish and install a NEMA One, Class One Switchboard. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the International Building Code (IBC) Site Classification as based on installed location zip code. The manufacturer shall provide the tested baseline mounting location information to the Electrical Subcontractor. The installing Electrical Subcontractor shall complete all required installation calculations and mount the unit based on the engineered to site plans.

B. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

C. All sections of the switchboard shall be a minimum of 90 inches high and group distribution sections shall be no more than 30 inches deep. All vertical sections shall rear align.

D. All switchboard components shall be either front or side accessible. Where space for future is called for, all necessary bus extensions except devices connecting straps shall be provided.

E. The switchboard assembly and all circuit breakers shall be rated for short-circuited stresses as indicated on Drawings.

F. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

G. All main bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure). No portion of the horizontal bus shall extend within 8 inches of the bottom or within 8 inches of the front inside any vertical panel section of the switchboard structure.

H. All exterior and interior steel surfaces of the switchboard shall be properly

cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating.

I. The switchboard shall have an UL service entrance equipment label.

J. The switchboard layout and rating shall be as indicated on the plans and shall have the following features:
   1. Service entrance shall be by means of conduit entering from the bottom.
   2. Provide a main molded case circuit breaker for ratings 1600 amperes and below. Provide main insulated case circuit breaker for all ratings 2000 amperes and above. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87.
   3. Provide Digitrip or equal electronic trip unit with integral GF protection on all main breakers. Provide thermal magnetic or ETU for feeders as shown on Drawings.
   4. Provide National Electrical Code compliant arc reduction maintenance protection with separate maintenance settings, activation switch and light for all main breakers.
   5. Main section shall be equipped with a line side digital power quality meter style IQ 260 or equivalent. Unit shall monitor voltage, amperes, power usage, and harmonic content displayed on the board and available for interface via modbus communications. Mount the unit in a separate compartment with system rated AIC disconnect device and shorting block for Line mounted CT's.
   6. Each switchboard section shall have full ampere bussing with full neutral capacity. A ground bus bonded to each cubicle shall run throughout the switchboard and all buses shall be copper.
   7. Internal busing and circuiting shall conform to the power riser diagram shown on the plans.
   8. Distribution sections shall consist of circuit breakers group mounted with bolted connectors to bus all front accessible. See schedule on Drawings for frame size and trip unit types.
   9. Where shown on drawings provide Electric Utility Company metering section that meets all local electric utility company requirements. Provide CT and PT units if required by the electric utility company. Provide all required documentation for electric utility company compliance review prior to construction of the switchboard.

K. The switchboard shall be a Pow-R-Line C as manufactured by Eaton, Square D, Siemens, or equal.

2.3 PANELBOARDS

A. At each location indicated on the plans, furnish and install an appropriate panel of the ampacity and voltage rating shown on the Drawings.

B. All panels shall be of the safety dead front circuit breaker type for service on three phase, four wire mains unless otherwise specified. All panels shall be of code gauge steel.

C. Panels shall be surface or flush mounted, as indicated on the plans, and installed so that the top circuit breaker is no more than 6'-0" above the finished floor.

D. The panelboards shall bear the Underwriters' Laboratories Label.

E. All buses shall be copper. All panelboards shall have a circuit directory card mounted in a frame with plastic cover installed on the inside of the door. All directory cards shall be properly filled in, using a typewriter, and indicating areas and devices served by each circuit.

F. All circuit breakers shall be of quick-make and quick-break type on manual operation, trip-free, and with inverse time characteristics and shall have bolted bus connections; plug-in circuit breakers will not be allowed.

G. Panelboard trims shall have single doors. Trims and doors shall be made of code gauge, full finish sheet steel. The trim and doors shall be factory finished on both sides. All panelboards shall be keyed alike.

H. Panelboards shall contain circuit breakers indicated on panelboard schedule on the Drawings. Two and three pole breakers shall be common trip type.

I. All panelboards shall be equipped with a neutral bar having one solderless connector for each circuit as indicated and with all required knockouts.

J. Panelboards requiring 200% neutrals and isolated ground shall be as indicated on the Drawings.

K. Panelboards shall be Square D, Type NQOB for 120/208 volt, Type NEHB for 277/480 volt, and I-Line for main distribution panelboards, Eaton/Cutler-Hammer, Siemens, or equal.

L. Provide panelboards with Nema 4X enclosure in Kitchen, Servery, and other wash down areas.

M. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87.

N. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

2.4 PULL BOXES, JUNCTION BOXES AND WIREWAYS

A. Pull boxes shall be of code gauge galvanized steel with screw covers to match. Pull boxes and wireways shall be as shown on Drawings and/or comply with the National Electrical Code and/or job conditions, with steel barriers separating systems.

B. Wireways shall be of code gauge steel, baked enamel manufactured standard sections and fittings, with combination hinged and screw covers, as manufactured by Square D “Square-Duct,” Bee Line, Cope or equal.

C. Conductors passing through pull boxes and wireways shall be identified to indicate their origin and termination. Provide nameplates for all pull boxes.

D. Weatherproof junction boxes installed in grade shall be polymer concrete with

gasketed cover, minimum 6" X 8" as manufactured by Quazite, Nordic Fiberglass, High Line Products, or approved equal.

2.5 OUTLET BOXES AND ACCESSORIES

A. Outlet boxes and accessories shall be as manufactured by Steel City, Appleton, Raco, or equal.

B. Lighting outlets in concrete ceilings, walls and columns shall be 4" octagonal rings, 4" deep with round bottom plate. Where concrete slab is less than 5" thick, boxes shall be 2-1/2" deep.

C. For wood framing and furred ceilings use 4" octagonal outlet boxes, bar hangers and covers. 4-11/16" boxes and covers shall be used where 1" conduit is involved.

D. Where outlets occur in beams or ribs of pan type concrete construction, a 4" shallow pan outlet, 3/4" deep, shall be used with conduit entering the back of the box.

E. All fixture outlet boxes shall have 3/8" solid make fixture studs and all auxiliary fixture stems shall be supported from 3/8" male fixture studs.

F. All outlets in walls other than lighting outlets in concrete shall be Series 52171, 4" square boxes with single of 2- gang raised covers, Series 52C50, of the proper depth required for the particular wall construction and finish. Where the wall construction or finish will not permit a neat cut around the raised cover, Series GW235 boxes shall be used.

G. Outlets in 2" partitions shall be 4" square, 1-1/4" deep, with raised cover.

H. Outlet boxes for weatherproof concealed work and exposed rigid conduit work shall be suitable cast or malleable iron conduit fittings, Crouse-Hinds Company, Appleton, Killark, or equal, and shall have threaded conduit hubs.

I. Floor outlets shall be as indicated on Drawings.

J. Fire rated poke through's shall be as indicated on Drawings.

2.6 CONDUIT

A. Electric metallic tubing shall be electrogalvanized or sherardized steel and the rigid steel conduit shall be hot-dipped galvanized or sherardized, inside and outside, manufactured by one of the following: Pittsburgh Standard, Republic Steel Corp., Allied Tube and Conduit Corp. or equal.

B. Flexible metal conduit shall be galvanized steel and shall contain a separate copper grounding conductor. Liquid-tight flexible metal conduit shall be similar, but shall also have an extruded moisture and oil proof outer jacket of polyvinyl chloride plastic.

C. Non-Metallic Conduit (NMC): Rigid polyvinyl chloride (PVC) shall be Schedule 40, rated for use with 90 degree conductors, UL rated or approved equal, conforming to industry standards and NEMA TC-2, NEMA TC-3, Fed. Spec. W-C-1094, and UL 651.

D. Rigid steel conduit fittings, couplings and connectors shall be threaded and shall be galvanized or cadmium plated. Conduit fittings and outlet boxes shall be held in place by fittings of a type approved by the Architect. Steel supports or racks shall be galvanized steel channel and fittings, Unistrut, Kindorf or Husky Products Company, or equal.

E. Couplings and connectors for electric metallic tubing shall be galvanized steel of the compression type other than the identer type and with insulated throat or set-screw type.

F. Steel support rods or support bolts for conduits shall be 1/8” diameter for each inch or fraction thereof of diameter of conduit size, but no rod or bolt shall be less than 1/4” in diameter.

G. Conduit shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members.

2.7 WIRE AND CABLE

A. Wiring shall be a minimum of #12 AWG solid, except motor control circuit wiring and fire alarm system wiring may be #14 AWG. Wiring for 120V branch circuits which exceed a distance of 100' from the panel to the last outlet shall be #10 AWG, 200 ft. from the panel to the last outlet shall be #8 AWG and 300 ft. from the panel to the last outlet shall be #6 AWG minimum, wiring for 277V branch circuits which exceed a distance of 200' from the panel to the last outlet or light fixture shall be #10 AWG, and 300 ft. from the panel to the last outlet or light fixture shall be #8 AWG minimum. The Electrical Subcontractor shall be required to perform voltage drop calculations on all branch circuits in which the actual proposed routing of the circuit exceeds 100 ft. to insure a maximum voltage drop of 3% is not exceeded. Wire sizes shall be increased to maintain the maximum 3% voltage drop.

B. Wires and cables shall be single conductor, except as otherwise specified or indicated on Drawings. Wires of sizes #8 AWG and larger shall be stranded. Wires of sizes smaller than #8 AWG shall be solid. Conductors shall be of soft drawn copper and shall have a conductivity of not less than 98% of the ANSI Standard for annealed copper. If, in the opinion of the Architect, the order and delivery time of solid conductors in the smaller sizes will delay progress of the installation, the Electrical Subcontractor may use stranded conductors instead of solid. If this permission is granted, pressure type connectors (not wire nuts) shall be used in making all such conductor splices, and particular care shall be taken when cutting insulation from ends of conductors not to score or sever conductor strands. Pressure type connectors shall also be used at all terminals.

C. Wire shall be Type THWN-2, XHHW or approved equal, rated 90 degrees C. minimum and suitable for wet and dry locations.

D. MC cable may be used for branch circuit wiring only, where run concealed, where allowed by Code and approved by the Authority Having Jurisdiction. Type MC cable shall be supported and secured at intervals not exceeding six feet.

E. Wire and cable shall be by one of the following: Phelps Dodge Copper Products Corp., General Cable Co., AFC Cable Systems, Triangle Conduit and Cable Co., or equal.

F. Terminal lugs and splice connectors shall be of an ampacity equal to the circuit on which they are utilized.

G. Emergency feeders that cannot be run in conduit below grade shall be Mineral Insulated Metal – Sheathed Cable (MI Cable), refer to Specification Section.

H. All wiring where run in environmental air plenums shall conform to Article 300-22 of the National Electrical Code.

I. Wiring shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members.

2.8 WIRING DEVICES

A. Light Switches
1. All local wall switches shall be of the flush quiet toggle type, single pole, double pole, three-way or four-way, and as manufactured by Pass and Seymour, Inc., Hubbell, Leviton Manufacturing Co., or equal.
2. All switches shall be suitable for the control of tungsten filament lamps, and shall carry the proper marking of the Underwriters' Laboratories.
3. Local switches shall be installed in such a position that they shall bear evenly and truly, and be secured on the axis of the supporting members.
4. Under no circumstances are wooden wedges, shims or blocks to be used in truing up local switches. Should the outlet box in any case come too far back of the finished surface, recess boxes and screws of the proper length to reach the box shall be used of such a size as to form a shoulder at exactly the proper point to retain the switch in position.
5. Switches shall be equal to the following:
Single Pole Pass and Seymour 20 AC-1 (20 AMP-1P)
Double Pole Pass and Seymour 20 AC-2 (20 AMP-1P)
Three-Way Pass and Seymour 20 AC-3 (20 AMP-1P)
Four-Way Pass and Seymour 20 AC-4 (20 AMP-1P)
Switch with pilot light Pass and Seymour 20 AC-1-CPL (20 AMP-1P)
Key switches shall be equal to corresponding switches above.
6. Dimmer switches shall be slide control dimmers with preset, Pass and Seymour, Leviton Manufacturing Company, Lutron, Wattstopper or equal, rated for 2000 watt, 120 volt AC operation.
7. Color of switches shall be white, unless otherwise noted.

B. Receptacles
1. Duplex receptacles shall be grounding type, rated 20 amperes, 125 volts. Receptacles shall be back and side wired with screw type terminals or pressure type, screwless terminals having suitable conductor release arrangement.
2. Ground fault duplex receptacles shall be furnished and installed where shown on the plans.
3. Special receptacles for single equipment, where required, shall have additional grounding leg and shall be of capacity for the equipment to be connected.
4. In general, convenience receptacle circuits shall be independent of lighting circuits and shall not be controlled by lighting circuit breaker

switches or lighting switches, unless specifically indicated on the Drawings.

5. Receptacles shall be as follows, or as manufactured by Hubbell, Leviton Manufacturing Co., or equal:
   a. Normal circuit duplex receptacles - Pass and Seymour 5362 (Provide child proof tamper resistant receptacles in the Child Development Areas or Rooms).
   b. GFCI Duplex receptacles - Pass and Seymour 2091S
   c. Receptacles with isolated ground - Pass and Seymour IG 5362 – Color of receptacles shall be orange.
   d. Computer circuit duplex receptacles – Transient surge suppression – Pass and Seymour 5362-GRYSP – Color of receptacles shall be gray.
   e. Computer circuit duplex receptacles – Pass and Seymour 5362-GRY – Color of receptacles shall be gray. All receptacles circuited to “C” panelboards shall be gray.
   f. Emergency circuit duplex receptacles – Pass and Seymour 5362-R – Color of receptacles shall be red.
   g. GFCI duplex receptacles installed on the exterior of the Building shall be “Weather Resistant” Type.
6. USB Charger Devices shall be as follows, or as manufactured by Hubbell, or equal:
   a. 20 amp, 2 USB chargers and duplex tamper resistant receptacle (3.0 amp) – USB20X2W.
   b. 20 amp, 4 USB charger receptacle (5.0 amp) – USB4W.
7. Color of receptacles shall be white, unless otherwise noted.

2.9 WIRING DEVICE PLATES

A. All device plates shall be Specification Grade, .032” thick, Type 430, stainless steel, brushed finish. Plates shall be of appropriate type and size for all wiring and control devices.

B. Plates shall be set so that all edges are in contact with the mounting surface. Plaster fillings will not be allowed. Multi-device locations shall have one common device plate.

C. Nameplate designation for device plates shall be engraved directly on plates and filled in black.

D. Device plates shall be by the same manufacturer as devices.

E. All receptacle device plates for circuits other than 120V, 2 wire, shall be engraved with 1/4” high letters, filled black, indicating voltage characteristics of the outlet.

F. Plates for surface type boxes shall not overlap boxes and shall be designed for use with surface boxes.

G. Device plates for circuits connected to the emergency distribution system shall have engraved nameplates marked “Emergency Circuit,” 1/4” high letters, filled in black.

H. Device plates for weatherproof receptacles shall be clear Polycarbonate “In-Use” type, pad lockable.

2.10 LIGHTING FIXTURES

A. Furnish all labor, materials and equipment required for a complete installation of lighting equipment specified on the lighting fixture schedule. This shall include plaster frames for all recessed fixtures whether or not itemized or specified on lighting fixture schedule which appears on Drawings.

B. Electrical Subcontractor shall assume all responsibility for the safe handling of all lighting fixtures which are furnished under this Section and other accessories and lamps until the final inspection has been made by the Architect.

C. Special fittings and materials that may be required to support fixtures shall be supplied as well as supports or grounds required to secure surface or pendant mounted fixtures on suspended ceilings unless otherwise noted. Fixtures shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members. This support shall be in addition to regular fixture support bars, and saddles. Fluorescent fixtures mounted in association with suspended or integrated ceiling systems shall be supported above ceiling by threaded 1/4” diameter continuous galvanized steel hanger rods or #12 jack chain. Each such fixture shall have two supports per fixtures. Where duct work, pipes, type of Building construction materials and structural framing members provide obstructions or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels in an approved manner. Steel support channels shall be Unistrut, Kindorf, Huskey Products, or equal. Rigid steel conduit may be used instead of steel support channels for size and method of support. Exact mounting height of all stem supported lighting fixtures shall be determined on the job by Architect.

D. Ballasts for fluorescent fixtures shall be the series type, classified for sound rating A, be CBM rated and shall have automatic resetting thermal protection as per latest Class P requirements as set forth by Underwriters Laboratories, 800 m.A. ballasts shall be sound rated Class B, and 1,500 m.A. ballast shall be a minimum sound rating of Class C.

E. Ballasts shall be of the normal power factor type unless otherwise noted. Proper ballast shall be furnished and installed for all lighting fixtures normally designed for operation with ballasts, whether or not such ballasts are specifically itemized on fixture schedule. This shall include not only fluorescent type fixtures but also all other fixtures employing high intensity discharge lamps.

F. Ballasts for fluorescent or other high intensity discharge lamps used outdoors shall be of the low temperature type, designed for operation down to a temperature of minus 20 degrees F.

G. If fluorescent fixtures operate improperly due to overheating, Electrical Subcontractor shall furnish and install ballast heat radiators to alleviate the condition, at no cost to the Owner.

H. Furnish and install a complete set of new lamps for all fixtures. Lamps shall be General Electric, Philips, or Osram/Sylvania. The Electrical Subcontractor shall furnish to the Owner, at the completion of the project, spare lamps equal to 10%

of the installed quantity for each type of lamp installed.

I. Fixtures, part or parts thereof (including lamps) determined defective upon completion of electrical installation shall be replaced by Electrical Subcontractor, at no cost to Owner.

J. Consult with General Contractor regarding arrangement of framing members to permit centering of recessed fixtures.

K. Consult with Ceiling Subcontractor and coordinate fixture locations and supports with suspended ceiling system.

L. Electrical Subcontractor shall be responsible for furnishing the specified recessed fixtures with proper mounting arrangement to be compatible with the type of ceiling construction in which fixture is to be mounted. If necessary, the type mounting arrangement shall be changed from that specified or indicated on fixtures schedule to conform to this requirement, at no additional cost to Owner. Submission of Shop Drawings of such recessed fixtures shall be interpreted to indicate that Electrical Subcontractor has verified ceiling construction, type and material with the Architect for the various areas of the project in which these fixtures shall be mounted. Shop Drawings of such fixtures shall be accompanied by a written statement indicating Electrical Subcontractor has verified such mounting arrangements with Architect and the date verified.

M. All suspended lighting fixtures shall be hung in association with improved aligner type hangers, except where noted.

N. In addition to fixture supports, surface mounted lighting fixtures shall be secured to surface which they mount at a minimum of two points on fixture housing to prevent rotation or movement of fixture out of its normal position of alignment.

O. After installation and lamping of permanent lighting fixtures and with approval of the Architect, these fixtures may be used for lighting, and will not require re-lamping prior to completion of project, except where lamps are faulty or burnt out.

P. Lamping color temperature shall be 3500°K for interior lighting fixtures, unless otherwise noted.

Q. Lamping color temperature shall be 4100°K for exterior lighting fixtures, unless otherwise noted.

R. Lamps which are to be dimmed shall be provided with minimum 100 hours of burn in time; Electrical Subcontractor shall not install lamps in dimmable lighting fixtures until this process is completed.

S. Lighting fixtures with multi wattage ballasts and drivers shall be labeled from the factory for the wattage specified to ensure compliance with Energy Code calculations.

T. All lighting fixtures that utilize LED (light emitting diodes) lamp sources shall be Energy Star rated or DLC (Designlights Consortium) qualified product listed, a kelvin temperature as scheduled having a color rendering index of 80 minimum and minimum L70 lifetime rating of 50,000 at 25°C ambient. LED array and driver packages shall have published IESNA LM-79 and LM-80 testing data as a

standard manufactured offering. Individual component testing will not be accepted. LM-79 must be conducted at a laboratory listed in the U.S. Department of Energy's LED Lighting Facts approved testing laboratories list. Testing must be conducted within the accreditation effective and expiration dates detailed for a given laboratory. In-house LM-80 reporting of LED array from LED manufacturer will be accepted.

U. Where lighting fixtures other than the specified products are provided, the Electrical Subcontractor shall provide light level calculations in accordance with IESNA standards to justify that substituted fixtures are of equal performance to the specified products (applies to all lighting fixtures in all spaces).

2.11 ELECTRICAL SUPPORTING DEVICES

A. All conduit and fittings on all work are to be secured by one or more of the following:
1. Masonry - metal clips secured by toggle bolts or lead expansion sleeves.
2. Woodwork - metal clips secured by wood screws.
3. Bar joists - wedge hangers.
4. Flanged beams - flange clips.

B. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building Code. The Electrical Subcontractor shall submit one (1) copy of Shop Drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet State Seismic Code requirements. Cable provided for seismic systems shall be color-coded and pre-stressed.

2.12 DISCONNECT SWITCHES

A. The Electrical Subcontractor shall furnish and install disconnecting means to comply with the National Electrical Code for all motors. Disconnect switches shall be fused or unfused as shown on the Drawings, NEMA Type HD safety switches for heavy duty, with interlocking cover, side operated with provisions for padlocking the switch handle in the off position.

B. All motor isolating switches indicated on the Drawings shall be rated in horsepower, and shall be rated for the voltage of the motor and shall be furnished and installed at the motor location whether or not the motor is within sight of the motor feeder disconnecting means.

C. Disconnect switch enclosures shall be of the proper NEMA type for the intended location as defined by NEMA and shall be phosphate coated or equivalent code gauge galvanized sheet steel with USAFI No. 24 dark gray baked enamel finish.

D. Disconnect switches shall bear the Underwriters' Laboratories label and be manufactured by Square D Company, Eaton/Cutler-Hammer, Siemens, or equal.

2.13 FUSES

A. General
1. Furnish and install a complete set of fuses for all fusible equipment on the project as specified by the Electrical Drawings. Final tests and inspection shall be made prior to energizing the equipment. This shall

include tightening all electrical connections and inspecting all ground conductors. Fuses shall be as manufactured by Mersen, Cooper Bussman, and Littelfuse, or equal.

B. Mains, Feeders and Branch Circuits

1. Fused circuits rated 601 amperes and above shall be protected by current-limiting Class L A4BQ fuses. Fuses shall be time delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in .01 seconds or less and be UL listed and CSA certified with an interrupting rating of 200,000 RMS symmetrical amperes.
2. Fused circuits rated 600 amperes or less shall be protected by current-limiting Class RK1 time delay A2D (250V) or A6D (600V) or Class J time delay AJT fuses. Fuses rated 8 amperes and above shall have the Smart Spot blown fuse indicator. This indicator shall provide guidance for ascertaining if the opening was caused by an overload or a short circuit. No holes are permitted in the fuse body for the indicator function. Fuses shall hold 500% of rated current for a minimum of 10 seconds (30A, 250V Class RK1 case size shall be a minimum of 8 seconds) and shall be UL listed and CSA certified with an interrupting rating of 200,000 RMS symmetrical amperes.
3. Metal end caps of fuses rated 61 through 600 amperes shall be electrically connected to the fuse blades to facilitate safe voltage testing during OSHA required LOTO (lock out/tag out) procedures.

C. Motors and Motor Controllers

1. Motor Protection
   a. All individual motor circuits shall be protected by Class RK1, Class J, or Class L time delay fuses.

- Motors under 10 H.P. ATDR fuses (Class CC) may be used on motors rated less than 10 H.P. at 480VAC and rated less than 5 H.P. at 240VAC. Fuse holders for Class CC fuses shall incorporate blown fuse indication.

   b. Fuse sizes for motor protection shall be chosen from tables published for the appropriate fuse. Heavy load and maximum fuse ratings are also shown for applications where typical ratings are not sufficient for the starting current of the motor.

APPLICATION INFORMATION

LOW VOLTAGE FUSES FOR MOTOR PROTECTION

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J, CC and L

MOTOR HP	FULL LOAD AMPERES	RECOMMENDED FUSE AMPERE RATING MOTOR ACCELERATION TIMES								
		MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.	MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.	MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.
460V		RK5–TRS (Tri-onic®)/RK1–A6D			J–AJT			UL CLASS CC ATDR		
1/2	1.1	1-4/10	1-6/10	2	1-1/2	1-6/10	2	3	3-1/2	4-1/2
3/4	1.6	2	2-1/4	2-8/10	2	2-1/4	2-8/10	3-1/2	5	6-1/4
1	2.1	2-1/2	3-2/10	4	2-1/2	3-2/10	4	5	6-1/4	9
1-1/2	3	3-1/2	4-1/2	5-6/10	3-1/2	4-1/2	5-6/10	6	9	12
2	3.4	4	5	6	4	5	6	8	10	12
3	4.8	5-6/10	7	9	6	8	9	12	15	17-1/2
5	7.6	10	12	15	10	12	15	15	25	30
7-1/2	11	15	17-1/2	20	15	17-1/2	20	25	30	-
10	14	17-1/2	20	25	17-1/2	20	25	30	-	-
15	21	25	30	40	25	30	40	-	-	-
20	27	35	40	50	35	40	50	-	-	-
25	34	40	50	60	40	50	60	-	-	-
30	40	50	60	70	50	60	70	-	-	-
40	52	70	80	100	70	80	100	-	-	-
50	65	80	100	125	80	100	125	-	-	-
60	77	100	125	150	100	125	150	-	-	-

a. To minimize arc flash incident energy, MCC's shall have fusible mains and maximum fuse ratings shall be as follows:

- A4BQ1200 for bolted fault currents greater than 40,000A
- A4BQ800 for bolted fault currents greater than 16,000A
- AJT600 for bolted fault currents greater than 14,000A
- AJT400 for bolted fault currents greater than 5,000A

Unit inserts (buckets) shall be fusible and protected by current-limiting Class J time delay (AJT) or Class RK1 time delay (A2D, A6D) fuses selected for Type 2 protection of the motor controllers based upon the motor controller manufacturer's published recommendations.

D. Other Equipment
1. Lighting and control circuits rated 600VAC and less shall be protected by Class CC time delay ATDR or ATQR fuses, sized according to the Drawings.
2. Switchboards, panelboards, and load centers shall utilize fully rated and listed components. Series rated overcurrent protective devices are not acceptable.

E. Labeling
1. Industrial control panel labels shall include a SCCR (short circuit current rating) and shall specify the overcurrent protection device upon which this rating is based as per the National Electrical Code.
2. Switchboards, panelboards, industrial control panels, and motor control centers shall include a label warning qualified personal of the potential arc flash hazard. The label shall be visible with equipment door closed.

F. Spares
1. Spare fuses amounting to 10% (minimum three) of each type and rating shall be supplied. These shall be turned over to the Owner upon project completion. Fuses shall be contained and cataloged within the appropriate number of spare fuse cabinets (no less than one), located per Drawings. Spare fuse cabinets shall be equipped with a key lock handle, be dedicated for storage of spare fuses and shall be ATFC.

G. Execution
1. To prevent mechanical damage to fuses; main, feeder, and branch circuit fuses are to be removed from equipment during transit and re-installed when equipment is to be energized.
2. As installed Drawings, showing actual fuses installed, shall be submitted to the Engineer after completion of the project.
3. Fuseholders capable of accepting Class H fuses are not acceptable.

H. Substitution
1. Fuse sizes indicated on Drawings are based on fuse performance and selectivity ratios. Alternative submittals to furnish materials other than those specified shall be submitted to the Engineer along with short circuit, selective coordination, and arc flash hazard studies.
2. Performance of any fuses submitted for substitution shall have:
a. Indication integral with the fuse so that it indicates the voltage transient when the fuse is opened. This is a relative measure of

how severe the fault was and gives information to the maintenance people to make them more efficient. No holes are permitted in the fuse body for the installation of indicators.

b. Only the listed UL categories must be used, in order to reduce the possibility of arc flash injuries. Class RK5 and Class H are prohibited and could cause major liability should an arc flash occur.

c. All end-caps of fuses must be electrically connected to the fuse blades to prevent misreading of electrical testers during the required OSHA LOTO (Lock-Out Tag-Out) procedures. Misreading on the LOTO final voltage check could cause hazardous shock.

2.14 STARTERS

A. Motor starters shall be furnished and installed by the Electrical Subcontractor except as noted otherwise in other Sections of this Specification.

B. All motor starters shall be of the maintained contact type and have individual running overload protection in each phase and shall be provided with two sets of auxiliary contacts (one normally open and one normally closed).

C. Starters shall be of size and type required for the particular motor horsepower and voltage.

D. Locate starters adjacent to panel feeding same unless otherwise indicated on the Drawings.

E. Manual starters shall be of the toggle mechanism type for full voltage starting.

F. Magnetic starters shall be across-the-line type, with means for remote control, except maintained contact type starters shall be used only where noted for specific items of equipment.

G. All starters shall have overload reset button, pilot light to indicate on or off and hand-off-auto switch in cover unless otherwise indicated.

H. Starters shall be furnished in the enclosures called for on the Drawings and shall be grouped whenever possible.

I. Motor starters, where grouped, shall be mounted on a new 3/4” thick exterior grade plywood mounting board finished to match starter enclosures.

J. All starters and remote control stations furnished under this Section shall have laminated plastic engraved nameplates designating the equipment controlled. Letters shall be 1/4” high.

K. Motor starters and controls shall be Square D, General Electric, Siemens, or equal.

L. All magnetic starters furnished under this Section which are connected to circuits operating at more than 120V shall have built-in control transformers with 120V secondary control supply.

M. Thermal trips for all motor starters supplied under this Section shall be ambient temperature compensated.

2.15 THERMAL SWITCHES

A. Thermal switches shall be NEMA Type 1 toggle switch for normal duty with thermal overload relay. Switch enclosures shall be of a type approved for the location and atmosphere in which it is mounted. Thermal switches shall be installed where called for or where required by Code. Thermal switches shall be provided with pilot where called for on the Drawings.

B. Thermal switches shall be as manufactured by Square D, Eaton, Siemens, or equal.

2.16 ACCESS PANELS

A. Provide access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required.

B. Access panels shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that junction can be easily reached and size shall be sufficient for purpose (minimum size 12” x 16”). When access panels are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

C. Access panels shall be as specified under Section 08 31 00, Access Panels and Doors.

2.17 DRY TYPE TRANSFORMERS

A. Transformers shall have separate primary and secondary windings. Transformers shall be UL listed insulation systems of 220 degrees C., with 150 degrees C. temperature rise above 40 degrees C. ambient, except sizes less than 10 KVA may be 185 degrees C., UL listed insulation system with 150 degrees C. temperature rise above an ambient of 40 degrees C. Transformers larger than 10 KVA shall be of ventilated type.

B. Core and coil assembly shall be supported from the enclosure base and shall have sound insulation pads between core and coil assembly and the enclosure base. KVA and voltage ratings shall be as indicated on Drawings.

C. Transformers shall be designed for natural draft cooling conforming to applicable ANSI and IEEE Standards. Six 2-1/2% full capacity taps shall be provided, two above and four below rated voltage. Noise level shall not exceed 45DB on 15 to 50 KVA, 50DB on 51 to 150 KVA transformers and 55 DB on transformers over 150 KVA.

D. Connection to transformers shall be made with liquid- tight flexible conduit with grounding conductor. Transformers shall be installed in association with Korfund vibration isolation pads to reduce noise level to a minimum. Refer to schedule on

Drawings for mounting arrangement. Transformers shall be manufactured by Square D, Cutler-Hammer, Siemens, or equal.

2.18 EMERGENCY STANDBY SYSTEM

A. Furnish and install a complete and operating emergency power system as specified herein and as indicated on the Drawings.

B. The system shall be arranged to provide automatic and instantaneous power upon loss of normal power. This system shall meet all Code requirements for emergency lighting and power.

C. Furnish complete, install and leave in good running condition a 500 KW diesel fueled engine driven generating set continuously rated for standby service. The KW rating shall be continuously available during any power outage. The unit shall be as hereinafter described and as shown on the Drawings, complete with all controls, attachments, accessories, fuel and exhaust systems.

D. The unit shall be the product of a manufacturer regularly engaged in the production of this type of equipment as manufactured by Kohler Company, Caterpillar Corporation, Onan Corporation or equal.

E. The unit shall be capable of accepting the incoming loads of the Automatic Transfer Switches.

F. Operation:
1. The operation of this unit shall be automatic and upon the closing of a remote starting contact in Automatic Transfer Switch, the engine shall start and attain rated voltage and frequency within ten (10) seconds.
2. All necessary accessories shall be provided to assure starting within the time described above under the ambient conditions described herein.
3. Furnish and install all electrical work and equipment required for the proper operation of this system. The General Contractor will provide the necessary structured supports for the emergency generator. The Electrical Subcontractor shall provide weight information, as well as dimensional information of the generator to the General Contractor, prior to installing the supports, if necessary.

G. Emissions;
1. The proposed generator set shall be EPA Tier 3 Certified and in compliance with the Commonwealth of Massachusetts Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with EPA Tier 2 emissions standard per ISO 8178 – D2 Emissions Cycle at specified ekW/bHP rating. Utilization of the “Transition Program for Equipment Manufacturer’s” also known as “Flex Credits” to achieve Tier 3 certification is not in compliance with MA Regulations “310 CMR 7.02 U Plan Approval and Emission Limitations” and will not be accepted.

H. Engine:
1. The engine shall be unit-mounted radiator cooled, 4 cycle, industrial type, heavy duty, diesel fueled, and a maximum RPM of 1800. Ratings shall be for standard conditions of 29.92 barometer and 60 degrees air

temperature.

2. Lubrication shall be a full pressure system using an engine driven gear-type lube oil pump with replacement element full flow lube oil filter. Oil cooler shall be required.
3. Base Mounted Fuel Tank:
   There shall be a double wall diesel fuel storage tank and rupture alarm supplied as an integral part of the base of the unit. The tank shall be furnished and constructed in accordance with Commonwealth of Massachusetts and City requirements for fuel storage. The fuel tank shall be installed in the generator manufacturer's factory and all fuel connections, vents, returns and fills shall be installed and tested prior to shipment. Field or dealer installed tank installations are not acceptable. Tank shall be sized to provide 48 hours of run time, at 100% load.

   The fuel tank shall meet all CMR 527 and Board of Fire Preventions Regulations and be accompanied with approval seal.

   This installation shall include but shall not be limited to the following:
   -Double wall steel fuel tank of the rated capacity
   -Enlarged steel skid base
   -Fuel lines including supply, return and vent lines
   -Fuel fill
   -Fuel level gauge
   -Low fuel warning float switch
   -Rupture basin and alarm
   -Low fuel level alarm relay

   All required appurtenances recommended or required by the manufacturer for a complete and correct installation shall be supplied and the entire assembly shall be factory primed and painted in the manufacturer’s standard color to protect against corrosion.
4. Diesel Fuel System
   a. The engine fuel system shall include all equipment normally supplied and recommended by the generator set manufacturer for standby generator service. The fuel engine system equipment shall include (but not be limited to) the following:
      -fuel injection system
      -fuel line solenoid valve
      -flexible fuel connections
5. Governor:
   a. The engine shall be equipped with a isochronous governor capable of +/- 0.25% steady-state frequency regulation.
6. Starting System:
   a. The engine shall have a 24 V.D.C. starting system with 24 volt positive engagement solenoid shift starting motor and 35-ampere minimum automatic battery charging alternator with solid state regulation.
   b. Batteries - One set of starting batteries with cables and steel battery rack, shall be included, capable of delivering the manufacturer's recommended minimum cold-cranking amps required at 0°F, per SAE Standard J-537.
   c. Float type battery charger shall be supplied to maintain the starting batteries at full charge. The charger shall be a 10-ampere automatic float and equalize battery charger with +/- 1%

constant voltage regulation from no load to full load over +/- 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambients from -40°C to +60°C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Alarm circuit board to meet the requirements of NFPA 110 for low battery voltage, high battery voltage, and battery charger malfunction shall be provided.

d. There shall be a belt driven battery charging alternator with regulator and charge rate ammeter for charging the batteries while the engine is running or the float type battery charger may be arranged to charge the batteries from the normal source when the engine is shut down and from the generator output when the generator is operating. This shall be accomplished by a relay energized from the generator output.

7. Jacket Water Heater:
   a. An engine jacket water heater shall be provided to maintain the engine jacket at a temperature high enough to assure starting the engine and attaining rated voltage and frequency within ten (10) seconds. The jacket water heater shall be of the capacity recommended by the generator set manufacturer to meet the above conditions. Input to the voltage heater shall be 208 volt, single phase.
8. Safety Shutdown:
   a. The engine shall be equipped with safety contacts for:
      -Low lube oil pressure
      -High jacket water temperature
      -Overspeed
      -Overcrank
9. Engine Instruments:
   a. The following engine instruments shall be connected either in an engine instrument panel or in the generator control panel:
      -Lube oil pressure
      -Water temperature
      -D.C. ammeter
      Any other instruments considered necessary by the manufacturer shall be included.
10. Exhaust System:
    a. A critical grade exhaust silencer suitable for residential type silencing complete with condensate drains shall be supplied of the size recommended by the generator set manufacturer, but in no case less than 4 inches. Silencer shall be as manufactured by Kettell, Maxim or Burgess Manning. An octave band center frequently in Hertz data sheet shall accompany all muffler shop Drawings. A section of seamless, flexible stainless steel exhaust connection of the size and type recommended by the generator set manufacturer, but in no case less than 4-inch diameter and eighteen (18) inches long shall be supplied. If the engine is Vee type, a single exhaust outlet header shall be supplied. The generator stack shall comply with 310 CMR 7.26 (42). Stack height shall be a minimum of 10'-0" above the emergency generator weather housing for generators rated equal to or greater than 300KW but less than 1MW. For emergency

generators rated 1MW and above, the stack shall be 1.5 times the height of the height to the top of the generator enclosure. Manufacturer to verify required height to meet 310 CMR 7.26 (42).

11. Mounting:
    a. The engine and generator shall be close coupled and mounted on a structural steel base designed to maintain proper alignment of the unit.
    b. The unit shall be certified by the manufacturer to be free from any critical torsional vibrations within a range of plus or minus 10% of synchronous speed.
    c. Vibration isolators of the type shall be supplied with the unit. The number of isolators shall be as recommended by the generator set manufacturer.

I. Generator:
1. Rating - 500 KW, 625 KVA, 0.8 P.F., 3 phase, 60 cycle, 480/277 volts.
2. Type - Revolving field, 4 pole, single bearing, drip-proof.
3. Exciter - Brushless, direct connected, fully tropicalized, SCR rectifiers, static voltage regulator, rheostat, excellent motor starting capability.
4. Voltage Regulation - Plus or minus 1% of any preset value over the three (3) phase load range. Instantaneous voltage dip or rise, when measured with an oscilloscope, will not exceed 20% upon full load applications or rejection, and will return to preset value within 0.5 seconds.
5. Waveform - Deviation factor of output voltage will not exceed 5% and the value of any individual harmonic will not exceed 2% of the fundamental when operating with an unbalanced load.
6. Temperature Rise - Temperature rise of any component will not exceed the rise permitted by NEMA standards.
7. Rotor - One (1) piece laminations welded and secured to shaft by a key and press fit. Armortisseur windings installed and connected between poles as an aid to parallel operation and improved waveform during unbalanced loads. Field coils machine would on insulated pole body and securely braced. Rotor statically and dynamically balanced.
8. Stator - One (1) piece laminations welded together. Stator coils form wound and placed in insulation slots. Stator pressed and welded in a rigid steel frame.
9. Bearing - Double sealed ball bearing, lubricated for life.
10. Insulation - NEMA Class F insulation.
11. Varnish - Three (3) coats modified polyester type, will not support fungus growth.
12. Cooling - Cast aluminum fan mounted on generator shaft.
13. Radio Suppression - Radiated or conducted radio interference will not affect normal commercial apparatus.
14. Controls:
    a. Unit Mounted - The engine generator set shall include a combination engine generator control panel shock mounted at the generator end of the unit. This unit mounted panel shall include (but not be limited to) the following:
    -Water temperature gauge
    -Oil pressure gauge
    -D.C. battery charge rate ammeter
    -A.C. voltage regulator
    -Voltage adjusting rheostat

-Start-stop switch
-A.C. voltmeter
-A.C. ammeter with current transformers
-Combination VM-AM phase selector switch
-Frequency meter
-Elapsed time meter
-Automatic start stop control with:
overcrank protection (manual reset)
high water temperature
overspeed
overcrank
selector switch - “off, auto, manual”
-Common failure relay (wire to fire alarm control panel as trouble alarm)
-Manual reset line circuit breakers as indicated on Drawings furnished with generator, 277/480 volts. Mounted in NEMA 1 enclosures with interrupting capacity of 65,000 amps symmetrical. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

b. The control shall be designed to start the engine upon a closure of a remote contact, arm all safeties, and shutdown the engine when the remote contact is reopened.
c. The control must be manually reset following any fault condition.
d. Control power shall be from the engine start battery.

J. Annunciator Panel:
1. A remote mounted engine generator annunciator panel shall be built, tested and supplied by the generator supplier. The annunciator panel shall monitor, visually and audibly, the following:
-Alarm Silence
-Generator Test
-Line Power
-Generator Power
-System Ready
-Alarm Switch off
-Generator Switch off
-Overcrank
-Low Battery Voltage
-High Battery Voltage
-Overspeed
-Emergency Stop
-Low Oil Pressure
-High Water Temperature
-Low Fuel
-Low Water Temperature
-Approach Low Oil Pressure
-Approach High Water Temperature
-Main Tank Rupture

K. Automatic Load Transfer Switches:
1. Automatic transfer switches shall be furnished with full load current rating

as indicated on Drawings, 277/480 volts, 3 phase, 4 wire, 4 pole, 60 Hertz, A.C. normal and emergency. Minimum AIC rating shall be 65,000. The transfer switches shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Underwriters' Laboratories, Inc., standard UL-1008. Emergency loads (ATS-2) shall be Step 1, while Optional Standby loads (ATS-1) shall be Step 2.

2. The transfer switches shall be double throw, actuated by a single electrical operator momentarily energized; and connected to the transfer mechanism by a simple overcenter type linkage with a total transfer time not-to-exceed one-half (1/2) second. The transfer switches shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position without the use of hooks, latches, magnets, or springs; and shall be silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole.
4. The transfer switches shall be equipped with a manual operator that is designed to prevent injury to the operating personnel, if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly.
5. The transfer switches shall be equipped with an elevator pre-signal contact.
6. Engine starting contacts shall be provided to start the generating plant, if any phase of the normal source drops below 70% of rated voltage, after an adjustable time delay period of three (3) to thirty (30) seconds, to allow for momentary dips. The transfer switches shall transfer to emergency, as soon as the voltage and frequency have reached 90% of rated voltage. After restoration of normal power on all phase to 90% of rated voltage, an adjustable time delay period of 0-30 minutes shall delay re-transfer to normal power, until it has had time to stabilize. If the emergency power source should fail during the time period, the time delay shall be by-passed, and the switches shall return immediately to the normal source. After the switches have retransferred to normal, the engine generator shall be allowed to operate at no load for an adjustable period of time (0-5 minutes) to allow it to cool before shutdown. The transfer switches shall include a test switch to simulate normal power failure pilot lights on the cabinet door to indicate the switch closed on normal or emergency and four (4) auxiliary contacts on the main shaft; two (2) closed on normal, the other two (2) closed on emergency. Included engine exerciser with 0-168 hours' timer.
7. Load transfer switches shall be as manufactured by Russelectric, ASCO, Westinghouse, or equal.
8. Provide two hour rated stop/start circuit from generator to all automatic transfer switches.

L. Test:

1. The supplier of the equipment shall provide at no additional charge, any information or supervision required for the proper installation of the equipment. Upon completion of the installation of this unit, a test run of four hours shall be conducted by the equipment manufacturer's factory

trained serviceman in the presence of the City Electrical Inspector. Using load banks to test full generator KW, at this time adjustments shall be made for correct operation of the equipment and the following readings taken at 15-minute intervals.
-Engine jacket water temperature
-Generator temperature
-Oil pressure
-Battery charge rate
-A.C. volts
-A.C. amps (all legs)
-Engine air exhaust temperature
-Engine oil temperature

2. The unit test shall also be made by utilizing available connected load. The supplier of this equipment shall also furnish and install lube oil in the engine and also drain and refill the engine with new lube oil after the engine-generator test has been completed. If the engine-generator unit should fail this initial test run, as determined by the representative of the Owner, after proper corrective measures have been implemented, replace engine lube oil again after the second test. If any additional tests are required to prove the performance of the engine-generator unit, lube oil shall be replaced after each test run.
3. Prior to shipment of generator to the job site, conduct a 3-hour full load shop test utilizing inductive load to attain full rated load. A written report of this test shall be forwarded to the Engineer for approval prior to shipment. All expense for these tests shall be carried by the Electrical Subcontractor.
4. A power outage test will be conducted by the Electrical Subcontractor, witnessed by the Commissioning Agent, using the Building load when all systems are completed. Electrical Subcontractor shall demonstrate proper operation of the emergency system to supply power to all emergency equipment during the simulated power outage and return back to normal utility service.
5. The Electrical Subcontractor shall pay for all fuel required for testing and shall leave the fuel tank full of fuel and the radiator full of antifreeze at the completion of testing and acceptance of the emergency generator.

M. Weather Housing

1. Weather housing shall be constructed of a minimum 16 gauge steel material. Fixed louvers shall be installed front and back to prevent blowing snow or rain from entering the housing. Roof shall have a crease down the length to prevent water from standing. Roof shall be braced, if necessary, to support the weight of silencer. Side panels and rear panels shall be lockable and removable for access to junction box. Locks must be heavy duty. Housing shall be free of any manufacturer's stickers and logos.
2. The enclosure shall be fabricated and mounted by the generator set manufacturer so as to insure compatibility of all systems. Seller-installed enclosures and enclosures provided by other than the manufacturer of the generator will not be acceptable. The complete assembly shall be factory finished and painted inside and out in the standard color of the manufacturer to help prevent against weathering and corrosion and to maintain an aesthetically pleasing appearance.
3. The enclosure shall be completed lined with a sound installation barrier.

This barrier must be not less than 1" thick and have a minimum density of 2 lbs. /3 cu. ft. In addition, material must meet UL-94 classification HF-1. This material is intended to absorb airborne noise within the enclosure.

4. The enclosure shall be sized such that all accessories specified herein including but not limited to:
   -Engine/Generator
   -Jacket heaters
   -Batteries
   -Battery charger
   -Base fuel tank
   -Exhaust
   -Line circuit breakers shall be housed within the enclosure.

N. Provide a cantilevered catwalk and railing assembly with a single stair that will attach to the base mounted diesel fuel tank that provides access to all enclosure doors and maintenance compartments. The catwalk, railing and stair assembly shall be manufactured of a non-rusting metal material and shall have grating on all walking surfaces. Stairs and railings shall conform to all federal and local building/safety codes. The entire assembly shall be epoxy painted. The assembly shall be shipped loose for installation on site.

2.19 TIME CLOCKS

A. Furnish and install time clocks where shown on the Drawings for the control of lighting.

B. Time clocks shall be shall be Tork DLC400BP, Intermatic, Paragon, or equal.
   1. Provide a 4 zone lighting controller with photosensor input (Tork model EPC2 photosensor to be supplied with controller).
   2. Memory Module shall be capable of being programmed at any one location and inserted into DLC400BP (with memory module socket) in any other remote location.
   3. Optional programmer shall be available (Model MMP), capable of accomplishing Windows based settings on a PC for easy duplication of Memory Modules or individualized programs for multiple locations.
   4. Each zone shall be capable of independent, user settable turn On and Off light level set points ranging from 1 to 100 footcandles.
   5. Three position slide switches shall be provided for each of the 4 zones allowing for user settings based on
      a. time of day or
      b. combination time of day and light level or
      c. light level.
   6. Controller shall provide 30 Amp general purpose isolated contacts (unpowered) for each zone as well as a 500 ma, 24VDC output.
   7. Controller shall have 1 digital input per channel for:
      a. remote contact closure which can be used to turn corresponding outputs On/Off outside of the normal control time or
      b. remote timed override which can be accomplished for the corresponding outputs with the use of Tork model SSA200R-24.
   8. Enclosure shall provide separate wiring compartments for power connections and auxiliary connections.
   9. Controller shall be capable of local override On or Off to the next scheduled event using the keypad for each zone.

10. Each zone shall be capable of astronomic function, adjustable from 10-60 degrees Northern or Southern latitude. Each zone can additionally be offset +/- 1-299 minutes for both sunset and sunrise.
11. Controller shall provide automatic daylight saving time (which can be omitted). Leap year adjustment shall be compensated for automatically.
12. Controller shall have 365 day holiday capability with 24 single dates and 4 seasons of unlimited duration.
13. Controller shall be capable of 99 set points with separate scheduling for each day of the week.
14. Controller shall have back-up capability:
    a. Schedule shall be retained for 40 years without power,
    b. real time shall be retained for 6 months using a field replaceable 9V lithium battery.
15. Unit shall have a NEMA type 3, metal indoor/outdoor enclosure.

2.20 FIRE ALARM SYSTEM

A. Furnish and install an addressable fire alarm system as indicated on the Drawings and as herein described. The equipment and installation shall comply with the current applicable provisions of the following standards:
1. NFPA 70 National Electrical Code
2. NFPA 71 Central Station Signaling Systems-Protected Premises Unit.
3. NFPA 72 National Fire Alarm Code
4. State Building Codes.
5. All requirements of the Local Authority Having Jurisdiction.
6. Underwriters Laboratories, Inc.
7. Massachusetts Electrical Code.
8. NFPA 101 Life Safety Code
9. Americans with Disabilities Act

B. The system and all components shall be listed by Underwriters Laboratories, Inc. for use in Fire Protective Signaling Systems under the following standards as applicable:
1. UL864 Control Units for Fire Protective Signaling Systems.
2. UL268 Smoke Detectors for Fire Protective Signaling Systems.
3. UL 268A Smoke Detectors for Duct Applications.
4. UL 217 Smoke Detectors, Single and Multiple Station.
5. UL 521 Heat Detectors for Fire Protective Signaling Systems.
6. UL 228 Door Closers-Holders for Fire Protective Signaling Systems.
7. UL 464 Audible Signaling Appliances.
8. UL 1638 Visual Signaling Appliances.
9. UL 38 Manually Actuated Signaling Boxes.
10. UL 1481 Power supplies for Fire Protective Signaling Systems.
11. City Fire Alarm Regulations.

C. General Requirements
1. Submittals
    a. Submit complete documentation for the Fire Alarm/Life Safety System showing the Model Number, type, rating, size, style, Manufacturer's Names, and Manufacturer's Catalog Data Sheets for all items to ensure compliance with these Specifications.
    b. Upon Contract Bid approval, and prior to start of system installation, submit Shop Drawings to and obtain written approval

from the Fire Department, prior to ordering fire alarm equipment. General requirements are as follows:

i. Submittal of fire rated sealant for penetrations.
ii. A riser diagram of the complete fire alarm system. (Typical riser diagrams are not acceptable).
iii. A complete point to point installation diagram. (Typical installation diagrams are not acceptable).
iv. A complete list of current drain requirements during normal supervisory, trouble, and alarm condition.
v. Battery standby calculations showing total standby power required to meet the specified system requirements.
vi. Supplier's qualifications indicating years in business, service policies, warranty definitions, and list of similar installations.
vii. Electrical Subcontractor qualifications, indicating years in business, prior experience with installations that include the type of equipment that is to be supplied, and installers license number and type of license.

c. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the fire alarm equipment standards. For equipment other than that specified, the Electrical Subcontractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Submit this information for approval by the engineer at least ten (10) days prior to bid.

2. Equipment Manufacturer's
   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. Equivalent equipment (compatible UL Listed) from other manufacturers may be substituted for the specified equipment.
3. General Equipment and Material Requirements
   a. All equipment and components shall be supplied by a factory authorized Notifier/NESCO affiliate. 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. All equipment covered by this Specification or noted on Installation Drawings shall be the best equipment suited for the application and shall be provided by a single manufacturer or be recognized and U.L. listed as compatible by both manufacturers.
   b. Furnish and install a full Microprocessor Based, Fire Alarm System according to the following Specifications and as shown on the Drawings.
   c. The system will permit maximum system expansion and owner flexibility with a minimum of additional field wiring. The system shall be wired, connected, tested, and left in first class operating

condition.

d. The system shall be totally solid state, microprocessor based, to ensure reliable operation, low maintenance costs, and long life.

e. The equipment and completed installation shall meet the approval of the Fire Department, the Authorities having jurisdiction, and in accordance with applicable Sections of NFPA 72 for Auxiliary Fire Alarm Systems, and National Fire Codes.

f. All fire alarm control panels shall be predominately red in color and have a white label with the words FIRE ALARM CONTROL PANEL on the front of the panel with a minimum four (4) inch letter size. No other functions shall be allowed in the panel (e.g. security system).

g. All fire alarm control panels shall provide 30% excess power supply capacity for future expansion.

h. All equipment shall be listed by Underwriters Laboratories.

i. Approved Equipment Suppliers

   i. Equipment and materials shall be as manufactured by Notifier or approved equal as manufactured by Edwards or F.C.I. Equipment designations and model numbers herein specified are those of Notifier. It will be the responsibility of the Engineered System 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.

j. All equipment shall be provided by one manufacturer, Notifier, Edwards, or F.C.I.

D. System Operation

1. The system shall provide means to detect fire conditions within a protected property, transmit the alarm to the Fire Department, alert Building occupants in which the alarm occurred with the use of a new fire alarm system communicator, to supervise each system for conditions which would impair proper system operation and to annunciate such abnormal conditions.
2. Except as permitted by the Fire Marshal, the operation of any alarm-initiating device shall cause the evacuation alarm to sound and be displayed on all evacuation signaling devices in all areas of the Building.
3. Systems designed to sound/display evacuation signals only in designated areas shall be provided with means to sound/display the evacuation signal on all connected devices. This means shall be provided at the control panel.
4. Audible/Visual devices shall be speaker / strobes listed for fire alarm service except as otherwise permitted.
5. Visual signaling devices shall be approved for the purpose and shall operate only in those areas where the evacuation signaling is required to be sounded and shall have the word "FIRE" permanently inscribed on their surfaces.
6. The system shall be electrically/electronically supervised against component failure of the entire audio path including wiring, switches and electrical contacts and shall detect opens, shorts, grounds or loss of signal, which might impair the function of the system.

E. Main Fire Alarm Control Panel:
   1. The FACP shall be a Notifier Model NFS2-640 or equal as manufactured by Edwards, or F.C.I. and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: addressable detectors, addressable modules, printer, annunciators, and other system controlled devices.
   2. Network Control Modules
      a. Network Communications Module (NCM-F) shall provide Fire Alarm Control Panels with a means to connect to NOTI•FIRE•NET.
      b. Main FACP located in school shall be equipped with a NCA-2 Network Control Annunciator.
      c. Nodes shall be interconnected via fiber-optic cable in minimum of 2” conduit.
   3. System Capacity and General Operation
      a. The control panel shall provide 318 intelligent addressable devices and be expandable to 636 intelligent addressable devices.
      b. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display, individual, color coded system status LEDs, and an alphanumeric keypad for the Field Programming and Control of the Fire Alarm System.
      c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the Fire Alarm Control Panel.
      d. The FACP shall provide the following features:
         i. Drift Compensation to extend detector accuracy over life.
         ii. Sensitivity Test, meeting requirements of NFPA 72.
         iii. Maintenance Alerts to warn of excessive compensation.
         iv. System Status Reports to display or printer.
         v. Alarm Verification, with verification counters.
         vi. PAS pre-signal, meeting NFPA 72 requirements.
         vii. Rapid manual station reporting (less than 2 seconds).
         viii. Non-Alarm points for general (non-fire) control.
         ix. Periodic Detector Test, conducted automatically by software.
         x. Pre-alarm for advanced fire warning.
         xi. Counting "cross-zone" options.
         xii. Temporal coding.
         xiii. Walk Test, with check for two detectors set to same address.
         xiv. Control-By-Time for non-fire operations, with holidays.
         xv. Day/Night automatic adjustment of detector sensitivity.
         xvi. Device Blink Control for sleeping areas.
      e. Central Microprocessor
         i. The Microprocessor unit shall communicate with, monitor, and control all external interfaces with the control panel. It shall include EPROM for system program storage; non-volatile memory for Building-specific program storage; and a "watch dog" timer circuit

to detect and report microprocessor failure.

ii. The Microprocessor unit shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.

iii. The Microprocessor Unit shall also provide a Real-Time Clock for time annotation of system displays, printer, and history file. The Time-of-Day and date shall not be lost if system primary and secondary power supplies fail. The Real Time Clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.

f. Display

i. The Display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

ii. The Display shall include status information and custom alphanumeric labels for all Intelligent Detectors, Addressable Modules, and Software zones.

iii. The Display shall provide an 80-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs) that will indicate the status of the following system parameters: POWER, FIRE ALARM, PRE-ALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, SIGNALS SILENCED and POINT DISABLED

iv. The Display shall provide a full QWERTY key touch pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.

v. The Display shall include the following operator functions: SIGNAL SILENCE, RESET, DRILL, ACKNOWLEDGE and LAMP TEST.

F. System Functional Operation

1. System Alarm Detection and Reporting.

a. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

i. The System Alarm LED shall flash.

ii. A local Piezo-Electric signal in the control panel shall sound.

iii. The 80-character LCD display shall indicate all information associated with the Fire Alarm condition, including: type of alarm point, its location within the protected premises, and the time and date of that activation.

iv. All system output programs assigned via control-by-event equations to be activated by the particular point in

alarm shall be executed, and the associated System Outputs (Alarm Indicating Appliances and/or relays) shall be activated.

a) A signal shall be sent to the Fire Department via masterbox. Provide a Gamewell 16 zone masterbox and antenna. Installation shall meet all Fire Alarm system requirements for masterbox connections as provided by the Fire Department.
   A signal shall be sent to a central station via telephone dialer. Provide (2) Cat 5E cable to Building telephone terminal board.
b) Close all fire doors.
c) Capture the elevator.
d) Shut down all HVAC units equipped with duct smoke detectors.

v. Unacknowledged alarm messages shall have priority over trouble messages, and if such an Alarm occurs during a Trouble sequence, the Alarm condition will have display priority.

2. System Trouble Detection.
   a. When a trouble condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
      i. The System Trouble LED shall flash.
      ii. A local Piezo electric signal in the control panel shall sound.
      iii. The 80-character LCD display shall indicate all information associated with the Fire Alarm trouble condition, including: type of trouble point, its location within the protected premises, and the time and date of that activation.
      iv. If any of the available optional serially connected equipment is being used, then each of the connected peripherals will display/print the information associated with the Fire Alarm Control Panel condition, including the time/date stamping of the change of status event.
      v. If applicable, all system output programs assigned via control-by-event equations to be activated by the particular point in trouble shall be executed, and the associated System Outputs (Trouble Indicating Appliances and/or relays) shall be activated.
   b. Unacknowledged alarm messages shall have priority over trouble messages, and if such an Alarm occurs during a Trouble sequence, the Alarm condition will have display priority.

3. System Common Control Switch Operation.
   a. Acknowledge (ACK/STEP) Switch.
      i. Activation of the control panel Acknowledge switch in response to a single new Alarm and/or Trouble condition shall silence the local panel piezo electric signal and change the System Alarm or Trouble LED from flashing mode to steady-ON mode. If additional new Alarm or Trouble conditions exist or are detected and reported in

the system, depression of this switch shall advance the 80-character LCD display to the next Alarm or Trouble condition.

ii. In this case, the local piezo sounder shall not silence, and the Alarm/Trouble LEDs shall not transfer to their steady-on mode, thus signaling to the operator that more Alarm/Trouble conditions are present in the system.

iii. Alarm conditions shall always have display priority before Trouble conditions. Depression of the Acknowledge switch shall cause a corresponding (time-stamped) message to be displayed on all system peripheral equipment (if used).

iv. Occurrence of any new Alarm or Trouble conditions in the system shall cause the Control Panel to resound the Local Piezo sounder and repeat the Alarm or Trouble sequences.

b. Signal Silence Switch.

i. Activation of the Signal Silence Switch shall cause all programmed Alarm Indicating Appliances and relays to return to the normal condition after an alarm condition. The selection of indicating circuits and relays, which are silenceable by this switch, shall be fully field programmable within the confines of all applicable standards.

c. System Reset Switch.

i. Activation of the System Reset Switch shall cause all electronically latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

ii. If the alarm condition(s) still exist, or if they re-occur in the system after System Reset Switch activation, the system shall then resound the alarm conditions.

d. Alarm Verification

i. The FACP shall provide Alarm Verification per point with tally. Each of the Intelligent/Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The Alarm Verification Function shall be from 0-60 seconds and each detector shall be able to be enabled/disabled during the field programming of the system, or any time after system turn-on. The Alarm Verification shall not require any additional hardware to be added to the Fire Alarm Control Panel.

e. System Reports.

i. The system will be able to generate and print a summary of all of the Detectors, Modules, Pull Stations, and Zones, which are currently active in the System. This printout will require password protection to prevent unauthorized user access, and will automatically print the system report using "soft" (single push) keys. No computer expertise will be required to initiate the System Report sequence. Provide one (1) printer.

f. Signal Silence Inhibit Time
   i. The Fire Alarm System shall be equipped with a Signal Silence Inhibit feature, which will prevent the operator from silencing any of the signals for a period of seconds. (0-300 seconds). The function of this Signal Silence Inhibit Timer shall be field programmable and its limit shall be field definable, without the need for the installation of any hardware modules into the system.

g. Automatic Signal Cutout Time
   i. The Fire Alarm System shall be equipped with an Automatic Signal Silence Cut-Out feature which will automatically silence all of the signals after a period of seconds. (000 none; 600 to 900 seconds). The function of this Automatic Signal Silence Cut-Out Timer shall be field programmable and its limit shall be field definable, without the need for the installation of any hardware modules into the system.

h. System Point Operations
   i. Device Disable
      a) Any Device in the system may be Enabled or Disabled through the system keypad without the need to reprogram or deprogram any of the operational parameters of the point such as Control-By-Event linkages
   ii. Output Point Control
      a) Any system output point may be turned on or off from the system keypad.
   iii. Point Read
      a) The system shall be able to perform a point status diagnostic function without the need for peripheral equipment to make the readings. Each point will provide the following parameters:
         i) Device Status
         ii) Device Type
         iii) Custom Device Label (32 character extended)
         iv) Zone CBE Selection
         v) Current Alarm Reading (percent)
         vi) Alarm Sensitivity Level
         vii) Pre-Alarm Sensitivity Level
         viii) Cooperative Multi-Detector selection
         ix) Alarm Verification
         x) Device SLC Address
         xi) Switch Inhibit (on/off)
         xii) Silenceable/Non-silenceable
         xiii) Walk Test
   iv. Point Status Report
      a) Upon command from a password-authorized operator of the system, a report will be generated which details each and every installed detector, module, zone, and annunciator, as well as any and all field programmed parameters which have been assigned to these points and

(optionally) printed.

x. System History Recording and Reporting
   a) The Fire Alarm Control Panel shall contain a History Buffer, which will be capable of storing up to 800 system output/input/control activations plus a separate 200 event alarm-only file. Each of these activations will be stored and time and date stamped with the actual time of the activation, until a password authorized operator requests that the contents be either displayed, or printed. The contents of the History Buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History Buffer Reports (whether Displayed or Printed), will be instantly distinguishable from all other displayed or printed system reports through the use of a semicolon in the time/date stamp of the data.

xi. Automatic Detector Maintenance Alert
   a) The Fire Alarm Control Panel shall automatically interrogate each Intelligent System Detector and shall analyze the detector responses over a period of time. The FACP shall provide three levels of Maintenance Alert.
      i) Low Chamber Value. This warning shall indicate that there is a hardware problem in the detector.
      ii) Maintenance Alert. This warning shall indicate that the dust accumulation is near but below the allowed level and that the detector needs maintenance before the detector performance is compromised.
      iii) Maintenance Urgent. This warning shall indicate that the dust accumulation is above the allowed limit.

xii. Voice Control Module.
   a) The voice control (speaker-circuit) module shall provide four fully supervised Class A Style Z NAC speaker circuits. An expansion circuit board will allow for expansion up to eight circuits per module.
   b) Each speaker circuit shall be capable of switching up to 30 watts maximum per circuitor 60 watts per four circuit module.
   c) The module shall provide green ON/OFF LEDs and yellow trouble LEDs.
   d) Each speaker circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.

xiii. Voice Control Center.
   a) Shall provide hand held microphone with priority

push to talk switch.

b) Shall provide all call switch and indicator to quickly activate all speaker circuits.

c) Shall provide custom digital message, tone generator and amplifiers.

G. Monitor Module

1. Monitor Modules, Model No. FMM-1, shall be provided to connect one supervised IDC zone of conventional Alarm Initiating Devices (any N.O. dry contact device, including 4-wire smoke detectors, manual pull stations, waterflow devices and supervisory devices), 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, to a surface mounted back box, or directly into the Fire Alarm Control Panel.
2. The IDC zone may be wired for Style D or Style B operation. The Monitor module shall provide address-setting means using rotary decimal switches and shall also 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 module is operational and in regular communication with the control panel.

H. Control Module

1. Control Modules, Model Number FCM-1, shall be provided to supervise and control the operation of one conventional Indicating Appliance Circuit (IAC) of compatible, 24 VDC 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, or directly in the Fire Alarm Control Panel.
2. The IAC may be wired for Style Z or Style Y IAC (Up to 48 Watts of Audio Speaker or 1 Amp of Inductive A/V Signal, or 2 Amps of Resistive A/V Signal) operation.
3. Audio/Visual 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 Amplifier.
4. The Control Module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code, which the Control Panel shall use to identify the type of device. An 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.

I. Relay Module

1. The addressable relay module, FRM-1, shall provide the system with a dry-contact output for activating a variety of auxiliary devices, such as fans, dampers, and control equipment. Addressability allows the dry contact to be activated, either manually or through panel programming. The Relay Module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, or to a surface mounted backbox, or directly in the Fire Alarm Control Panel.

J. Isolator Module

1. Isolator Modules, Model Number ISO-X, shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered

inoperative by a short circuit fault on the SLC Loop. If a wire-to-wire short occurs, the Isolator Module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically re-connect the isolated section of the SLC loop. The Isolator Module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation. The Isolator Module shall mount in a standard 4-inch deep electrical box, in a surface mounted backbox, or in the Fire Alarm Control Panel. It shall provide a single LED, which shall flash, to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

K. Addressable Manual Stations

1. Addressable Manual Stations, Model Number NBG-12LX, shall be provided to connect one addressable, supervised Manual Station to one of the Fire Alarm Control Panel Signaling Line Circuit (SLC) Loops.
2. The Manual Station shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. Manual Fire Alarm Stations shall be non-crush tube type with a key operated test-reset lock, and shall be designed so that after actual Emergency Operation, they cannot be restored to normal use except by the use of a key. All operated stations shall have a positive, visual indication of operation and shall clearly show the word “ACTIVATED” upon activation. Manual Stations shall be constructed of LEXAN with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single gang box, and shall be installed within the limits defined by the American with Disabilities Act (ADA). The Manual Station shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code, which the control panel shall use to identify the type of device. An LED shall be provided which shall flash under normal conditions, indicating that the Manual Station is operational and in regular communication with the control panel. The LED may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. The station shall provide a key reset. The key shall be the same as used for the fire control panel.
3. Color of device shall be red.

L. Intelligent and Addressable Photoelectric Smoke Detectors

1. The Intelligent Photoelectric Detectors, Model Number FSP-851, shall be Intelligent and Addressable, and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The detectors 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.
2. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic switch, or may be activated remotely on command from the control panel. The detectors shall provide address-setting means on the detector

head using rotary decimal switches. Because of the possibility of installation error, systems that use binary jumpers or dipswitches to set the address are not acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.

3. The detectors shall provide dual alarm and power LEDs providing 360 degree viewing angle. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be controlled through the system field program. An output connection shall also be provided in the base to connect an external remote alarm LED. Detectors that do not provide a 360-degree viewing angle will not acceptable.
4. The detector sensitivity shall be set through the Fire Alarm Control Panel, and shall be adjustable in the field through the field programming of the system. There shall be 9 levels of alarm sensitivity and 9 levels of pre-alarm sensitivity to choose from.
5. The detector shall also have the ability to be set for Self-Optimizing that will allow the detector to set itself to the best suited sensitivity.
6. The detector shall display its address, at the detector, during Walk Test.

M. Intelligent Addressable Duct Smoke Detector

1. The Intelligent Addressable Photoelectric Duct Detectors, DNR with FSP-851R shall be Intelligent and Addressable devices, and shall be connected with two wires to one of the Fire Alarm Control Panel Signaling Line Circuits.
2. When sufficient smoke is sensed, an alarm signal is initiated at the fire alarm control panel and appropriate action is taken to shut off fans and blowers and change over air handling systems, throughout the areas served by the duct system.
3. Remote Test Station, RTS1515KEY, shall be provided as shown on the plans.
4. The Electrical Subcontractor shall wire from the duct smoke detector to its respective unit motor starter to shut the unit down upon detection of smoke. The duct smoke detector shall activate the Building's alarm notification appliances.

N. Intelligent Heat Detectors

1. The Intelligent Heat Detectors, Model Number FST-851, shall be Intelligent and Addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line circuits.
2. The detectors shall use an electronic sensor to measure thermal condition caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements. The heat detector shall provide a Fixed 135 degree or a 135-degree Rate of Rise detection as indicated on the Drawings.
3. The detectors shall be ceiling-mount and shall include a twist-lock base.
4. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
5. The detectors shall provide address-setting means on the detector head using a decimal switch. Because of the possibility of installation error,

systems that use binary jumpers or dipswitches to set the address are not acceptable.

6. The detectors shall provide dual alarm and power LEDs providing 360 degree viewing angle. Both LEDs shall flash under normal conditions. In certain applications, LEDs may be selected to be polled without flashing through system programming. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. Detectors that do not provide a 360-degree viewing angle will not be acceptable.
7. An output connection shall also be provided in the base to connect an external remote alarm LED.
8. The heat detector shall display its address, at the detector, during Walk Test.

O. Carbon Monoxide Detectors

1. Furnish and install, where shown on the plans, carbon monoxide detectors, Ultraguard Model CODET 12-24 or equal. Carbon monoxide detectors shall operate on 24 volts and shall be wired through a separate monitor module as a zone and power supply. Altronix Model AL300ULXR or equal.

2. Carbon monoxide detectors shall be wired as a supervisory signal. Provide all necessary relays and wiring.

P. ADA High Intensity Strobe Audio-Visual Alarm Indicating Appliances

1. Notifier Model SPSR speaker/strobe with multi candela capability shall be listed with Underwriter's Laboratories for use with Fire Protective Signaling Systems. speaker/strobe shall have a minimum sound output of 96dB @ 10 feet and shall be flush mounted. The speaker shall sound in a Temporal pattern. The strobe shall have a candela rating that meets or exceeds the requirements of the Americans with Disabilities Act (ADA) and shall be of such rating as shown on the Drawings. The device shall be rated at 24 VDC nominally and have an acceptable operating range of 20-30 VDC.
2. The device shall mount to a 4" square deep with extension ring.
3. All strobes shall be synchronized.
4. Color for ceiling mounted device shall be white and color for wall mounted device shall be red, unless otherwise noted.

Q. ADA High Intensity Strobe High Audio Output/Audio-Visual Alarm Indicating Applicances

1. Wheelock high performance speakers (ET70-W) and series speaker strobes (ET70-24MCW-FW) shall provide high audio output, clear audibility and field selectrable taps from 1/8 to 8 watts.
2. Any additional amplifiers shall be provided to accommodate required wattage.
3. The device shall mount to a 4” square deep with extension ring.
4. All strobes shall be synchronized.
5. Color of devices shall be white, unless otherwise noted.

R. ADA High Intensity Strobe Only Unit

1. Notifier Model SR as shown on Drawings, shall be listed with Underwriter's Laboratories for use with Fire Protective Signaling Systems

and accepted by the local Authority Having Jurisdiction. The strobe shall meet or exceed the requirements of the Americans with Disabilities Act (ADA) and shall be of such rating as shown on the Drawings. The device shall be rated at 24 vdc and shall have a flash rate of 1 HZ.

2. All strobes shall be synchronized.
3. Color for ceiling mounted device shall be white and color for wall mounted device shall be red, unless otherwise noted.

S. Exterior Strobe Light

1. Maxi-Signal 490S series. The exterior strobe shall also be of weather-resistant rain tight construction.
2. Provide weatherproof backbox.
3. Weatherproof strobe shall be installed where directed by the Fire Department.
4. Color of device shall be red.

T. Magnetic Door Holders

1. Furnish and install, where shown on the plans, magnetic door holders, Notifier Model FM series. Magnetic door holders shall operate from 120VAC.
2. The housing and contact plates shall be brushed zinc finish. Units shall have a holding force of approximately 35 pounds.

U. Stopper Covers

1. Provide Notifier Model STI1100 stopper covers on all manual pull stations. The protective shield shall be tamper proof, clear lexan with red frame installed over the fire alarm pull station. When the protective shield is lifted to gain access to the manual pull station, the protective shield shall sound a loud, piercing warning horn. The horn shall be battery powered and may be silenced by lowering and re-aligning the protective shield. Each stopper cover shall include a battery and the Electrical Subcontractor shall furnish two dozen spare batteries for replacement parts.

V. LCD Alphanumeric Display Annunciators:

1. The Alphanumeric Display annunciators shall be a supervised, local or remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English test.
2. The LCD annunciators shall display all alarm and trouble conditions in the system.
3. The annunciators shall connect to an EIA 485 interface,
4. Up to 32 LCD annunciators may be connected to the interface, each with Acknowledge, Silence and Reset controls for the FAC.
5. Provide a graphic annunciator adjacent to each LCD annunciator. The graphic annunciator shall conform to Fire Department requirements.

W. Fire Alarm/Life Safety System Installation

1. Provide and install the system in accordance with the plans and Specifications, all applicable Codes, and manufacturer's' recommendations. All wiring shall be installed in strict compliance with all the provisions of National Electrical Code, Power Limited Fire Protective Signaling Circuits or if required may be reclassified as non-

power limited and wired in accordance with National Electrical Code. Upon completion, the Electrical Subcontractor shall so certify in writing to the Owner.

2. Removal of a smoke detector will not interfere with the transmission of signal from manual stations, waterflow switches, and other initiating devices.
3. All Equipment shall be attached to a non load-bearing wall, and shall be held firmly in place. Fastening and supports shall be adequate to support the required load, and provide a safety factor of five.
4. As indicated on the Riser/Connection Diagram Drawings, each system alarm point or zone in the system shall be uniquely labeled within the Fire Alarm Control Panel. Names of the system point(s)/zone(s) shall be as defined by the Engineer.
5. Fire Sprinkler Activation detecting System(s) shall each be indicated on a separate zone in the Fire Alarm Control Panel.
6. Fire Alarm Control Panel will be mounted with the center of panel 60 inches above floor level.
7. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color codes shall be maintained throughout the installation.
8. Cable and Wiring.
    a. Conduit and Conductors: Provide complete wiring and conduit between all equipment. Unless otherwise specified within the Installation Manual of the specific equipment being used, all field wiring shall be minimum #14 Type in separate conduit, maximum 40% full, and shall be approved for use as Fire Alarm cable. Conduits of proper size shall be installed from the Control Panel; Equipment to field devices. All field devices shall be mounted upon U.L. Listed Electrical junction boxes. All splices in field wiring shall be made in U.L. Listed Electrical junction boxes. All Electrical junction boxes shall be labeled as "Fire Alarm System" with decal or other approved markings. The Fire Alarm/Life Safety Installation shall comply fully with all Local, State and National Codes, and the Local Authority Having Jurisdiction (AHJ).
    b. The Fire Alarm Control Panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the Main Power Distribution Panel as FIRE ALARM. Fire Alarm Control Panel Primary Power wiring shall be 12 AWG. The Control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod. Conduit shall enter into the Fire Alarm Control Panel backbox only at those areas of the backbox, which have factory conduit knockouts.
    c. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; an audible and visual trouble signal will be activated until the system and its associated field wiring are restored to normal condition.
    d. Fire alarm MC cable shall be allowed above ceilings, in attics and in other areas allowing surface wiring if so approved by the Local Authority Having Jurisdiction.
    e. Cable shall be the type listed for Fire Alarm/Life Safety use and shall be installed per National Electrical Code.
    f. Cable for Addressable/Intelligent Alarm Initiating Appliances

(Manual Stations, Heat Detectors, and Smoke Detectors) shall be connected as shown on the riser diagram. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Signaling Line Circuit (SLC) loop. The connection and continuity of the wires, which make up that SLC loop will be continuously supervised for shorts, opens, and ground circuit conditions.

g. Cable for Alarm Initiating Devices and Appliances (Manual Stations, Heat Detectors, and Smoke Detectors) shall be connected to the Fire Alarm Control Panel, and labeled as shown on the riser diagram. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Initiating Device Circuit (IDC) loop. The connection of the cable to that loop will be continuously supervised for shorts, opens, and ground circuit conditions.

h. Cable for Alarm Indicating Appliances (Audible or Visual or combination signal(s)) shall be connected on a per zone basis. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Indicating Appliance Circuit (IAC) loop. The connection of the cable to that loop will be continuously supervised for shorts, opens, and ground circuit conditions.

i. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per National Electrical Code.

j. All exposed cable below 84 inches from the surface of the finished floor, or other locations where the cable may become exposed and/or damaged, must be within a steel conduit.

k. Conduits must also be provided in elevator shafts and hoist ways. Cables within ducts or plenums must conform with the Specifications of the National Electrical Code.

l. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or back boxes, except where conduit entry knockouts have been provided by the factory.

m. Cable shall meet all the manufacturer's requirements including shielding, twists, capacitance, resistance and gauge. The cable shall not be installed without approval of the manufacturer in writing.

X. Final System Acceptance.

1. The system will be accepted only after a Factory-Trained Distributor in the presence of the Electrical Subcontractor, the owner’s representative and the Local Fire Marshal have accomplished a satisfactory test of the entire system, in accordance with NFPA 72. Upon completion of a successful test, the Electrical Subcontractor shall so certify in writing to the Owner. The Electrical Subcontractor shall pay all back charges assessed by the Fire Department for all fire alarm system tests.
2. The Electrical Subcontractor shall submit, in the Shop Drawings, a letter confirming that they will provide a U.L. listed testing company to provide the acceptance test.
3. The Electrical Subcontractor will present a complete set of "As- Built" Fire Alarm/Life Safety system Drawings, and the factory supplied Operator's Manual to the Building Owner's Representative and the local AHJ.

4. The Electrical Subcontractor 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.
5. The Electrical Subcontractor 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

Y. Warranty
1. The Electrical Subcontractor shall warrant the completed fire alarm system, wiring and equipment, to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of the first beneficial use.

2.21 PUBLIC SAFETY SIGNAL BOOSTER SYSTEM

A. Furnish and install a signal booster system complete with all components and wiring required for compliance with all applicable Codes and Regulations. The system shall include but not be limited to the following:
1. One donor antenna to be located on the roof. Run a ½" plenum rated non-radiating coaxial cable from the directional antenna to the Bidirectional Amplifier (BDA). Cable shall be equal to ICA12-50JPLW (1/2" plenum coax).
2. This Specification is based upon an NFPA Compliant TX/RX Rescue Line SBII system. The BDA shall be a TX/RX Rescue Line SBII, Motorola, and Bird Technologies, or equal. Frequencies shall be coordinated with the Fire and Police departments and the amplifier shall meet all Fire and Police department communications requirements.
3. Furnish a ½" plenum rated radiating cable from the BDA to above the corridor ceilings on each floor. At minimum provide radiating plenum rated radiating cable above the corridor ceilings paralleling the routing of the cable tray shown on the Drawings. Radiating cable shall be supported every 5'-0" from the cable tray with a 3" standoff. Provide antennas at a minimum of one every 200' along the radiating cable routing. Provide any additional cabling in strict accordance with manufacturer's Specifications as well as current National Electrical Code to provide complete coverage for the system. A pre and a post signal strength test shall be provided at the job site. Signal strengths shall be noted on a set of plans both pre and post test.

B. Vertical riser backbone cabling and associated splitters, couplers, and taps shall be installed in two hour rated electric rooms and shafts. Splitters, couplers, and taps throughout system shall be accessible for testing, future service, and/or replacement. Provide access panels where required. Where vertical riser backbone cabling exits two hour rated enclosure provide fire stopping around penetrations.

C. Signal Strength
1. The Fire and Police Department radio test shall check the signal reception in several locations on the floor area. Signal strength shall provide for clear reception throughout the Building utilizing the type of hand held radio unit that is used by the Fire and Police Department. Quantity of test locations shall be determined and conducted by the local

department representative. Each floor of the Building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand held transceivers.

D. Required Signal Levels:
   1. Signal strength shall provide for clear reception throughout the Building utilizing hand held radio units of the type(s), which are used by the Fire/Police Department. Signal strength testing shall follow TSB-88 standards using delivered audio quality measurements (DAQ).
   2. A minimum signal strength of –95 dBm (DAQ4) shall be available on over 99% of the floor area required to be covered when transmitted from the fire department.
   3. A minimum signal strength of –95 dBm (DAQ4) shall be received at the fire department system from over 99% of the floor area required to be covered.

E. Primary Power
   1. The emergency responder radio coverage system shall be powered by a dedicated independent circuit of sufficient size. The circuit shall be clearly marked. The location of the electrical panel shall be clearly marked at location approved by the fire official. The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA 72.

F. Secondary Power
   1. The emergency responder radio coverage system shall be equipped with a secondary source of power. The secondary source of power shall be a backup battery system which is serially connected to the BDA system (no UPS units). The secondary power supply shall supply power automatically when the primary power source is lost. The secondary source of power shall be capable of operating the emergency responder radio coverage system for a period of at least 12 hours at 100% system operation capacity. All components of the battery backup system shall be housed completely in a NEMA 4 or 4X cabinet and mount below the BDA. System shall have front panel display and alarms. Monitoring the integrity of power supplies shall be in accordance with NFPA 72. Unit shall be TX/RX 6160 Battery Option.

G. Alarm Monitoring Panel
   1. A dedicated monitoring panel shall be provided adjacent to the fire alarm control panel to annunciate the status of the signal booster. The monitoring panel shall provide visual and labeled indication of the following for the booster:
      a. Normal AC power
      b. Signal booster trouble
      c. Loss of normal AC power
      d. Failure of battery charger
      e. Low battery capacity

2. The above mentioned alarm points shall be outputs from the BDA system as dedicated relay points. These can be monitored via addressable monitor modules to the fire alarm system in lieu of a dedicated BDA monitoring panel.

H. All equipment shall have a current FCC Certification.

I. Equipment integrator shall be a certified service center with factory certified technician(s).

J. Warranty: The BDA shall include a 5 year equipment warranty. Include any necessary costs for equipment to contain this warranty level.

K. Submittals:
1. Submit manufacturer's data on system and components including Shop Drawings, floor plans with layout of all equipment, cabling, riser diagram for project (typical riser diagram is not acceptable), and mounting equipment and details.
2. Provide copies of personnel certifications in submittal.

2.22 ELECTRONIC SAFETY AND SECURITY

A. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Electronic Safety and Security Integrator, Section 28 00 00 as specified.

B. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes, pathways, power, cableways and J hooks to facilitate a neat and orderly installation of cables, cable protection, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves shall be brought to an accessible hallway ceiling or accessible area below floor), backboxes, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots where cables pass from one location to another, removal and re-installation of ceiling tiles to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the Systems Integrator. The Electrical Subcontractor shall install all specialized backboxes.

C. Responsibilities of the Electronic Safety and Security Integrator for this Section: The Electronic Safety and Security Integrator shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling and equipment specified in this Section for a completely operational system. The Electronic Safety and Security Integrator shall furnish all specialized backboxes to the Electrical Subcontractor for their installation.

2.23 CABLE TRAY

A. Conform to NEMA VE1.

B. Ladder Type Cable Trays:

1. Material: Aluminum 6036-T6 alloy.
2. Width: 20 inches overall.
3. Inside depth: 6 inches.
4. Cross rung spacing: 9 inches.
5. Minimum fitting radius: 24 inches.
6. Design Load: Provide tray capable of supporting 50 pounds per linear foot, when supported on 12 foot centers.
7. Hangers: 1/2 inch diameter threaded steel rods; furnish with pair of 1/2 inch nut and washers for each rod. Rods shall be supported from the structural floor above, independent of furred or suspended ceilings, unless otherwise noted.

C. Cable Tray Accessories
1. Fittings: Furnish tees, crosses, risers, elbows, and other fittings as indicated, manufactured with the same materials and finishes as the cable trays.
2. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.24 SCOREBOARDS

A. Furnish as hereinafter specified wall mounted Fair-Play electronic scoreboards as indicated on Drawings. Each scoreboard shall include all equipment as hereinafter specified and shall be a Model BB-1620-4 LED Digit with metric clock. Equipment in this Section shall be as manufactured by Fair-Play, Daktronics, Nevco, or equal.
1. Scoreboard Construction
a. BB-1620-4 LED Digit scoreboard
Provide BB-1620-4 scoreboards as indicated on Drawings, 9' 0" x 5' 0" displaying:
◊ Automatic second-by-second display of time remaining or time elapsed in minutes and seconds for periods up to 99:59 minutes or less. Metric clock shows tenths of a second and seconds during last minute, also two hour memory in case of power loss.
◊ Period number 0 through 9
◊ Bonus arrows
◊ Team scores 0 through 199
◊ Team fouls 0 through 99
◊ Uniform number 0 through 99
◊ Total fouls for individual player 0 through 9
◊ Volleyball and wrestling captions
◊ Time Advantage Clock
◊ Next possession indicators
◊ Gloss white enameled captions: “HOME” and “VISITOR”
◊ Operator’s master console with running time display, 10 ft. flexible cords to operate all functions and carrying case required
◊ Control receptacles with covers
◊ Assortment of spare lamps and fuses
◊ Complete set of operating and maintenance instructions
Scoreboard housing shall be of rigid completely enclosed, all aluminum construction, and are provided with brackets for wall mounting. Service access for

exchange of lamps of plug-in components is from the front of the housing and no tools shall be required. Exposed exterior surfaces shall be immersion etched and finished in dark non-reflecting enamels with gloss white captions and trim. Color to be selected by Architect.

◊ Receiver for wireless control.

b. Display Modules

LED digit numerals 12 in. high, for time and score and 10 in. high for period. All LED digits have a life expectancy of over 100,000 operating hours. Each numeral is covered by Lexanâ material protecting them from damage due to stray basketballs and volleyballs. Numerals shall appear amber, red and green on a jet-black background. Bonus arrows and possession arrows are red.

c. Electronic Systems

Electronics to be solid state low voltage encased in completely "plug-in" paks.

d. Battery Operated Control Console with Wireless Transmitter

i. Shall be Model MP-70 with padded carrying case. Requires 120V AC power of battery source and draws 12 watts. Construction shall be an aluminum case 12-3/4" long by 2-1/4" high by 8" deep with 4 rubber slide-resistant feel. Operating features shall include a two-line LCD readout showing information as sent to the scoreboard display as well as constant display of time remaining or time lapsed; a changeable color coded keypad to allow key identification change by sport, numeric key pad, plus and minus keys for quick sequential data entry, a push-type horn button and a positive action rocker switch for the "Time In" and "Time Out" function.

ii. Electronic features shall include a program mode allowing change in sport controlled or accommodation of a sport rules change, a memory circuit to retain information if power interrupted and electronic foul memory.

iii. Furnished with one battery with charger and one transmitter for battery operated wireless control.

iv. Provide one Control Console for each scoreboard.

e. Horn

i. The horn is a special Electronic constant duty scoreboard horn with a decibel level of 100.

f. Power Requirements

i. Model BB-1620-4: 120V.AC, 1 phase, 50/60Hz - 168 watts.

g. E.T.L./Electrical Testing Laboratory Approval

i. This scoreboard carries the E.T.L. label signifying this organization's testing and approval as a safe and dependable design.

C. Furnish and deliver as hereinafter specified Fair-Play electronic LED digit shot timers as indicated on Drawings. The shot timers shall be a Model ST-1410-4

LED digit and include all the equipment as hereinafter specified.

1. Shot Timer System
   a. ST-1410-4 Timer System
      The timer system operates from the MP-70 Scoreboard Control and consists of the following:
      - ◊ Provide a Shot Timer Hand Switch for each Control Console provided.
      - ◊ Display modules with vibrating horn and 18" power cord
      - ◊ 10 Ft. cords w/plugs on each end.
      - ◊ Receiver for wireless control.

   b. Shot Timer Construction
      The timer display unit shall be constructed of an all metal frame for indoor use and shall be approximately 17" x 20". Approximate wt: 50 lbs.

   c. Display Modules
      LED digit numerals shall be 12" high. All LED digits have a life expectancy of over 100,000 operating hours. Each numeral is covered by Lexanâ material protecting them from damage due to stray basketballs and volleyballs. Electrical connection to the timer display is by flat flexible printed Mylar circuitry. Insuring proper socket and connector alignment. Numerals shall appear red on a jet black background. Each display incorporates a vibrator horn and comes with 18" power cord.

2.25 DRY TYPE K-RATED TRANSFORMERS

A. Description
   1. This Specification describes the design of a copper wound, multi-shielded, three phase, K-factor rated, high efficiency, power conditioning isolation transformer. The power conditioning transformer specified must be a continuous duty rated, 600 volt class, convection cooled, dry type, isolation transformer to support harmonic rich non-linear loads while maintaining safe operating temperatures and shall include superior transverse and common mode noise attenuation. The power conditioning transformer shall meet NEMA TP 1-2002 dry type transformer efficiency standards. In addition, the transformer shall be designed to achieve NEMA TP 1-2002 Table 1-1 efficiencies under K-13 non-linear load at or between 35% to 50% of its rating as outlined in Section G, 10, of this Specification Section.

B. Standards
   1. The power conditioning system shall be designed in accordance with applicable portions of the following standards:
      a. NEMA TP 1-2002 Dry Type Distribution Transformer Efficiency Standards.
      b. American National Standards Institute (ANSI C57.110 and C62.41-1991).
      c. Institute of Electrical and Electronic Engineers (IEEE 519-1992).
      d. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC).
      e. Federal Information Processing Standards Publication 94 (FIPS Pub 94).

f. UL Listed to Standard 1561.
g. C-UL listed to CSA Standard C22.2, No. 47-M90.

C. Submittals
1. Manufacturer Requirements:
a. The manufacturer shall be ISO 9001:2008 “Quality Assurance Certified” and shall upon request furnish certification documents.
b. The manufacturer shall be a United States based manufacturer with at least 15 years’ experience in design and fabrication K-rated, shielded, power conditioning isolation transformers.
2. Product Data:
a. The manufacturer shall supply documentation for the installation of the system, including wiring diagrams and cabinet outlines showing dimensions, weights, BTUs, input/output connection locations and required clearances.
b. Factory test results and design data shall be provided to show compliance with the requirements.

D. Manufacturer’s
1. The equipment specified is the Ultra-K, Series 600K, manufactured by Controlled Power Company. Equipment shall be as manufactured by Controlled Power Company, Acme, Siemens, or equal.

E. Input Specifications
1. The nominal AC input voltage rating of the power conditioner shall be 480 VAC 3 phase with sufficient margin to sustain a constant input of +10% without saturation.
2. The nominal operating frequency shall be 60 hertz $\pm$ 3 hertz.
3. The power conditioning transformer primary shall be configured in a three phase delta. Transformers below 500kVA shall include full capacity taps at 2½ % increments, two (2) above and four (4) below the nominal voltage tap.
4. When energized, the current inrush shall not exceed a maximum of 10 times the full load input current for a 1/2 cycle.

F. Output Specifications
1. The nominal AC output voltage rating of the power conditioning transformer shall be 208 VAC wye derived, 60 hertz.
2. The output impedance of the power conditioning transformer shall be 3% - 4% typical.
3. The power conditioning transformer shall be K-13 rated in accordance with: $K = \sum Ih(pu)^2 h^2$
4. The power conditioning transformer shall provide a continuous duty, full load output power as indicated on Drawings.

G. Performance Specifications
1. The output voltage of the power conditioning transformer shall be maintained within $\pm$2.5% or less of nominal, from no load to full load.
2. The overload rating of the power conditioning transformer shall be 500% for 10 seconds, and 1,000% for one cycle.

3. The power conditioning transformer shall add no more than 1% total harmonic distortion to the output waveform under a linear load.
4. Output voltage shall remain sinusoidal with no flat topping when high crest factor (3.0:1), non-linear loads are present at the output.
5. The audible noise of the power conditioning transformer shall be no greater than measurements indicated below:
   a. 50 dB for 15 KVA to 112.5 KVA units measured at 1 meter.
   b. 55 dB for 150 KVA to 225 KVA units measured at 1 meter.
   c. 60 dB for 300 KVA to 500 KVA units measured at 1 meter.
6. The power conditioning transformer shall incorporate a solid copper foil, triple electrostatic shield to minimize inner winding capacitance, transient and noise coupling between primary and secondary windings.
7. Transformer shall be triple-shielded and capable of 146dB common mode noise attenuation.
8. Transformer shall be capable of transverse mode noise attenuation of 3 dB down at 10kHz, decaying 20 dB per decade.
9. The power conditioning transformer shall have an efficiency of 98% typical and shall meet NEMA TP 1-2002 dry type transformer efficiency standards on models 15kVA and above.
10. The power conditioning transformer shall be designed to achieve NEMA TP 1-2002 Table 1-1 efficiencies listed below under a K-13 non-linear load at or between 35% to 50% load and at an operating temperature of 75 degrees C.

kVA	Efficiency
15*	97.00%
30	97.50%
45	97.70%
75	98.00%
112.5	98.20%
150	98.30%
225	98.50%
300	98.60%
500	98.70%

*15kVA model efficiency applicable to K4 and K7 loading only.

11. The power conditioning transformer shall incorporate a fused (with front panel mounted, blown fuse lamp indicator) 3 phase, secondary connected, 6 mode spike suppression network. The suppressor shall be comprised of high energy metal oxide varistors with less than a 5 nanosecond response time and a maximum peak current handling capability of 40,000 amps (8x20μsec) per mode. The suppression network system shall remain functional when subjected to ANSI/IEEE C62.41 Category B-3 waveforms. The spike suppression network will increase the transverse mode noise attenuation to 3 dB down at 10kHz, decaying 40 dB per decade.

H. Main Transformer Construction
1. The transformer windings shall be all copper conductor construction, with separate primary and secondary, isolated windings. The transformer shall conform to National Electrical Code that specifies a separately

derived power source. The neutral conductor shall be provided at 2 times the ampacity of the phase conductor.

2. Terminals shall be provided for isolated three phase output conductors, neutral conductor and ground.
3. Output neutral shall be bonded to ground via a removable jumper wire or bus bar.
4. All leads, wires and terminals shall be labeled to correspond with the circuit wiring diagram.
5. Basic Impulse level shall be no less than 10,000 Volts.
6. Mean Time Between Failure (MTBF) shall be no less than 200,000 hours.
7. Grain oriented, M6 grade, silicon transformer steel shall be utilized to provide maximum efficiency. Flux density shall not exceed 15k gauss. Core losses shall be limited to 0.6% or less of the KVA rating.
8. Class N, 200°C insulation system shall be utilized throughout with a maximum temperature rise above ambient of 115°C under a linear load, not to exceed 130°C under non-linear loading per UL 1561.
9. The transformer shall be designed for natural convection cooling.

I. Cabinet Construction

1. The cabinet shall be a NEMA type 2 general purpose, floor mounted, indoor enclosure. Dimensions shall not exceed TABLE 1-2 dimensions below.
2. Cabinets shall be manufactured from 14 gauge steel with base sub-structure suitable for fork lifting.
3. The cabinet shall have a baked on powder coat paint finish with proper pre-treatment.
4. Input and output power connections shall be hardwired to copper stand off bus located behind the front panel of the transformer cabinet. Input and output locations shall be available on either side of transformer cabinet.

J. Environment

1. Temperature: The power conditioning system shall be required to operate without overheating in an ambient temperature range of -20°C to +40°C.
2. Humidity: The power conditioning system shall operate in a relative humidity of 0 to 95% non-condensing.
3. Altitude: The power conditioning system shall operate up to 5000 feet above sea level without de-rating.

K. Warranty

1. Manufacturer shall guarantee the power conditioning transformer to be free from defects in material and workmanship for a period of 2 years following shipment from the factory.

2.26 LIGHTNING PROTECTION

A. General:

1. Scope
   a. The work covered by this Section of the Specifications consists of providing services of a qualified lightning protection engineer, labor and materials required for the design and installation of a

functional and unobtrusive lightning protection system. System shall comply with the latest issue of Underwriters' Laboratories, Incorporated Master Label Code 96A and NFPA Code No. 780 Lightning Protection Systems. At the completion of the installation an Underwriters' Laboratories, Incorporated Master Label shall be furnished to the Owner.

b. If any departure from the Drawings or Shop Drawings covered below are deemed necessary by the Electrical Subcontractor, details of such departures and reasons therefore shall be submitted as soon as practicable to the Architect for approval. No such departures shall be made without prior written approval of the Architect.

2. Quality Assurance
   a. The system to be furnished under this Specification shall be the standard product of the manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. The equipment manufacturer shall also be an approved manufacturer. All material specified in this Section is manufactured by Heary Bros. Lightning Protection Company, Inc., 11291 Moore Road, Springfield, New York 14141. Lightning protection shall be as manufactured by Heary Brothers Lightning Protection Company Inc., Boston Lightning Rod Inc., East Coast Lightning Equipment, Inc., or approved equal.
3. Submittals
   a. Complete Shop Drawings showing the type, size, and locations for all equipment, grounds and cable routings, shall be submitted to the Architect for approval prior to start of work.
   b. Samples and pertinent catalog data shall be submitted to the Architect for approval upon request,

B. Products:

1. Standard
   a. All equipment shall be new, the product of a single manufacturer as outlined above, and of a design and construction to suit the application where it is used in accordance with accepted industry standards.
   b. Equipment
      i. All materials shall be copper or bronze and of the size, weight and construction to suit the application where used in accordance with requirements for Class I structures and as per manufacturer recommendations.
      ii. Conductors shall be copper, 29 strands, 17 gauge minimum, Heary Bros. Cat. No. HB-29-17C.
      iii. Air terminals shall be solid, round copper bar of 3/8" minimum diameter. Heary Bros. Cat. No. HB308C, and shall project 10" minimum above the object to be protected. Locate and space according to requirements.
      iv. Air terminal bases shall be of cast bronze with bolt pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Crimp type connectors are not acceptable.
      v. Heary Bros. Cat. No. HB16C, 32C, 38C. and 25C. Bases

on built-up tar and gravel roofs shall be secured with a proper adhesive and shall have a minimum surface contact area of 18.5 sq. inches, Cat. No. HB23C.

vi. Ground rods shall be a minimum 5/8" in diameter and 10'-0" long. Heary Bros. Cat. No. HB106GR. They shall be connected to the system with a two-bolt cast bronze clamp. Heary Bros. Cat. No. HB111X, having a minimum length of 1-1/2" and employing stainless steel cap screws.

vii. Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface and shall be spaced according to requirements. Heary Bros. Cat. No. HB66C, 72C, 64C.

viii. Bonding devices, cable splicers and miscellaneous connectors shall be of cast bronze with bolt pressure connections to cable. Cast or stamped crimp fittings are not acceptable. Splicers similar to Heary Bros. Cat. No. HB57C, 26C, 501C bonding devices similar to Heary Bros. Cat. No. HB54C, 97C, 178B, 57XXC, 42C.

ix. Equipment on stacks and chimneys shall be protected from corrosion and sized in accordance with requirements.

x. All miscellaneous bolts, nuts and screws shall be brass, bronze or stainless steel.

C. Execution:

1. Installation
   a. The installation shall be accomplished by an experienced installer. The installer shall work under the direct supervision of a manufacturer as listed above or his authorized representative.
   b. All equipment shall be installed in a neat workmanlike manner in the most inconspicuous manner as possible. The system shall consist of a complete cable network on the roof involving all air terminals, splices and bonds with cable downloads routed concealed in the Building construction in conduit to ground rod.
   c. Downlead cables shall not be brought directly through the roof. Conduit through proper roof flashings shall be utilized for this purpose.
   d. The Electrical Subcontractor shall furnish and install all necessary PVC conduit for concealed down conductors.
   e. Copper equipment shall not be connected to aluminum surfaces except by means of a bi-metal transition fittings. Lead coating is not to be accepted as a bi-metal transition.
2. Coordination
   a. The lightning protection installer will work with other trades to insure a correct, neat and unobtrusive installation.
   b. It shall be the responsibility of the lightning protection installer to assure a sound bond to the main water service and to assure interconnection with other Building ground systems, including both telephone and electrical. Proper arresters shall be installed on the power and telephone service by either the utility or the Electrical Subcontractor as applicable.

3. Completion
   a. The lightning protection installer shall secure and deliver the As-Built Shop Drawings to the Architect for the Owner upon completion of the installation.

2.27 COMMUNICATIONS SYSTEM

A. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Communications Integrator, Section 27 10 00, 27 21 33, 27 40 00, 27 50 00 and 27 70 00 as specified.

B. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes with plaster rings, floor boxes, poke through devices, pathways, power, cableways, J hooks, cable tray including cable tray over each rack and cabinet to facilitate a neat and orderly installation of cables, cable protection, wiremold, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves, shall be brought to an accessible hallway ceiling or accessible area below floor), backboxes, plaster rings, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots, where cables pass from one location to another, removal and re-installation of ceiling tiles to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the systems integrator. The Electrical Subcontractor shall install all specialized backboxes (clock, speaker, and amplifier) and any exterior antennas provided by the Systems Integrator.
   1. The Electrical Subcontractor shall be responsible for providing and installing: conduits from each IDF location back to the MDF location to comply with Code for applicable sound, voice, data and video cabling: conduits from the Point of Demarcation to the MDF location to comply with Code for applicable sound, voice, data and video cabling: conduits from the Video Headend location back to the MDF location to comply with Code for applicable video cabling.

C. Responsibilities of the Communications Integrator for this Section: The Communications Integrator shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment specified in this Section for a completely operational system. The Communications Integrator shall furnish all specialized backboxes (clock, speaker, and amplifier) and all exterior antennas to the Electrical Subcontractor for their installation.

2.28 ZERO SEQUENCE HARMONIC FILTERS

A. Quality Assurance
   1. Manufacturer shall be ISO 9001 certified.

2. Transformers shall be CSA certified and UL listed.
3. Transformers shall be EPA Energy Star listed.
4. Transformers shall be factory tested to CSA C9.
5. Transformers shall meet all relevant CSA, EPA, IEEE, NEMA, NFPA, and UL standards.

B. Submittals
1. Shop Drawings shall include:
   a. Enclosure dimensions.
   b. Mounting devices.
   c. Terminals.
   d. Taps.
   e. Internal and external component layout.
   f. Amperage (neutral).
   g. kVA rating.
   h. Voltage.
   i. Frequency.
   j. BIL level.
   k. Insulation class.

C. Operations and Maintenance Manuals
1. Operations and Maintenance Manuals shall include:
   a. Recommended environmental conditions.
   b. Recommended periodic inspections and maintenance.

D. Materials

1. Type 'I_0Filter™', Zero Sequence Harmonic Filter (Dry Type) to CSA C9.

E. Product Description – The design of the zero sequence harmonic filter, described in this Specification, shall be optimized for harmonic rich environments that are characterized by high neutral currents. These filters shall:
1. Provide an ultra-low zero sequence impedance path for all third order, load-generated zero sequence harmonic currents, including I_3, I_9, I_{15}, I_{21}.
2. Reduce neutral current between the point of filter application and the power source.
3. Reduce voltage and current distortion.
4. Reduce voltage and current imbalance.
5. Reduce CMN (neutral-ground voltage) at the point of application.
6. Reduce current crest factor.
7. Reduce average and peak phase.
8. Increase voltage stability during single-phase disturbance.
9. Reduce system losses.
10. Improve system power factor.
11. Harmonic cancellation shall be by electromagnetic means only. No capacitors or electronics shall be used.

F. Device Configuration
1. Type: ANN.
2. Insulation Class: 220^0C.
3. Temperature Rise: 150 Deg. C.
4. System Frequency: 60 Hertz.

5. System Voltage: 208 Volts.
7. BIL: 10,000 Volts (windings 1000V or less).
8. Rating: As indicated on Drawings.

G. Filter Characteristics
   1. Key Requirements
      a. Zero sequence reactance at 60Hz: <0.3.
      b. Zero sequence impedance at 60Hz: <0.9.
      c. Neutral connection shall be rated at three times the ampacity of the phase current.
   2. Basic Requirements:
      a. Built to the following Standards: CSA C9-M1981, CSA22.2 No.47-1977, UL-506, ANSI C75.110, and NEMA ST-20.
      b. Three-phase, common core construction.
      c. Convection air-cooled.
      d. Copper Windings.
      e. Type: ANN.
      f. Insulation Class: R.
      g. Temperature rise: $150^{0.}$
      h. Voltage Class: 1.2kV.
      i. BIL Rating: 10kV.
      j. Magnetic field at 1.5 feet: max. 0.1 Gauss.
      k. Full load Efficiency at 170°C: EPA Energy Star requirements.
      l. Sound level: per C57.12.91.
      m. Enclosure: ventilated, drip-proof NEMA-1.
      n. Finish: PQI super white power coat.
      o. Anti-vibration pads shall be used between the core and the enclosure.
   3. Options:
      a. Over-temperature alarm - wired to internal terminal strip:
         i. Contact (one per set point): normally closed.
         ii. Set point: 180°C.
         iii. Epoxy vacuum impregnation.

H. Vendor Information:
   1. Evidence of significant relevant application experience.
   2. Quantitative performance data including before/after effect on voltage distortion at load panels that demonstrates the capability to achieve the harmonic mitigation called for in this Specification.
   3. Product technical Specification.
   4. Pertinent product application information.

I. Certification:
   1. Manufacturer shall be ISO 9001 certified.
   2. Device shall be CSA certified and UL listed.
   3. EPA Energy Star listed.

J. Warranty:
   1. Manufacturer shall guarantee that the product will perform as described in Section E of this Specification Section.
   2. Manufacturer shall warranty the product against defective materials and workmanship.
   3. Minimum terms and conditions: 15 year, with standard limited liability clauses.

K. Acceptable Mfr and Product:
1. Power Quality International, Inc. – I.Filter™, Powersmiths, Square D, or equal.

2.29 LIGHTING CONTROL SYSTEM

A. Equipment provided under this Section shall be all manufactured by a sole manufacturer. Submittals with multiple manufacturers will not be accepted.

B. Introduction
1. The work covered in this Section is subject to the requirements in the General Conditions of the Specifications. Electrical Subcontractor shall coordinate the work in this Section with the trades covered in other Sections of the Specification to provide a complete and operable system.

C. System Description
1. Extent of lighting control system work is indicated by Drawings and by the requirements of this Section. It is the intent of this Section to provide an integrated, energy saving lighting control system including Lighting Control Panels, Occupancy Sensors, and Daylighting Controls from a single supplier. Electrical Subcontractor is responsible for confirming that the panels and sensors interoperate as a single system.

D. Quality Assurance
1. Manufacturer's: Firms regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
2. Comply with NEC, NEMA, and FCC Emission requirements for Class A applications.
3. UL Approvals: Relay panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Configured to order or custom relay panels shall be UL Listed under UL 508, Industrial Control Panels.

E. Submittals
1. Submit manufacturer's data on lighting control system and components including Shop Drawings, detailed point to point wiring diagrams, and floor plans showing occupancy and daylighting sensor locations. Provide typical mounting details for occupancy and daylighting sensors for this application.

F. Manufacturer's
1. This Specification is based upon products from WattStopper. Equipment shall be as manufactured by WattStopper, Lutron, Philips Controls, Crestron, Cooper, or equal. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the equipment standards. For equipment other than that specified, the Electrical Subcontractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment.
2. 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. Equivalent equipment (compatible UL Listed) from other manufacturers may be substituted for the specified equipment.

G. Lighting Control Panels

1. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
   a. Enclosure/Tub shall be NEMA 1, NEMA 3R, or NEMA 4 as indicated on the plans, sized to accept an interior with 1-8 relays, 1-24 relays and six (6) four pole contactors, or 1-48 relays with six (6) four pole contactors.
   b. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
   c. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (class 1) wiring from low voltage (class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
      i. Provision for one or two optional control and automation cards.
      ii. Removable, plug-in terminal blocks with screw-less connections for all low voltage terminations.
      iii. Individual terminal block, override push button, and LED status light for each relay
      iv. Switch inputs associated with each relay and group channel shall support two or three wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.
      v. Automatic support for occupancy sensor sequence of operation. Low voltage inputs automatically reconfigure when connected to a WattStopper occupancy sensor head. Occupancy sensor shall switch lighting on and off during unoccupied periods but shall not turn lighting off during scheduled occupancy periods.
      vi. Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
      vii. Automatic sequenced operation of relays reduces impact on the electrical distribution system when large loads are controlled simultaneously.
      viii. Group, channel, and pattern control of relays shall be provided through a simple button-press interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and

channel override push buttons and LED displays.

ix. Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.

x. Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.

xi. Single pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

a) Electrical:
   i) 30 amp ballast at 277V
   ii) 20 amp ballast at 347V
   iii) 20 amp tungsten at 120V
   iv) 30 amp resistive at 347V
   v) 1.5 HP motor at 120V
   vi) 14,000 amp short circuit current at 347V

b) Mechanical:
   i) Individually replaceable, ½" KO mounting with removable Class 2 wire harness
   ii) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel
   iii) Dual line and load terminals each support two #14 – #12 solid or stranded conductors
   iv) Tested to 300,000 mechanical on/off cycles
   v) Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

c) Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

d. The Dataline wire will be supplied by the equipment manufacturer and will include the manufacturer's name, catalog number printed on the wire jacket. The Electrical Subcontractor, at its own expense, will replace an improper dataline wire.

e. Panels shall be digitally addressed and support bi-directional communication between each other and other intelligent field devices specified elsewhere.

H. Advanced Communications, Integration and PC Connectivity

1. Provide an advanced communications network that supports optional features like PC connectivity, TCP/IP connections, advanced programming system documentation, enhanced diagnostics, historical and runtime accumulation, and graphic programming and control.
    a. The system shall support the following advanced operating scenarios:
        i. Adjustable override periods for after hour use based upon the day of the week.
        ii. Preemptive override before OFF to prevent blink warning and to start a new override time delay.
        iii. Allow common areas to remain ON when specific relays in a panel are ON. Egress timer starts a countdown when the last watched relay turns OFF.
        iv. Master Switch Control with blink option to provide a blink warning and five minute countdown for occupants when a master switch is turned OFF
        v. Interior daylighting control to turn OFF lights when available natural light meets occupants' lighting needs. Lights will only come on during occupied periods when enough natural light is not available.
        vi. Occupancy Sensor Integration: Allows relays to automatically follow occupancy sensors' status, or interlock the sensors with daily schedules (Relays stay ON during scheduled ON time, and follow sensors only during afterhours).
    b. Communications
        i. Each panel shall support RS232 twisted pair and optional RS-485 connections. Either protocol may be used for programming, monitoring, and control. The dataline shall allow simultaneous operation of multiple communications access points to support multiple operator terminals and communications with other Building automation systems.
        ii. Each panel shall be capable of stand-alone automatic operation and the network shall achieve full distributed processing.
        iii. All programming shall be accomplished with a Windows based PC running compatible software package.
    c. Hardware Features
        i. Each communication control card shall be capable of providing all logic, control, runtime data, status information, and communications functions for up to 48 relays in a panel.
        ii. EEPROM power loss memory and clock holdup time: 30 days
        iii. Self-diagnostics: Automatic diagnostics on all memory, input/output card modules, relays, and dataline.
        iv. Clock: Digital with time, day of week, and date. Automatic leap year compensation. Programmable Daylight Savings Time and Standard Time adjustment.
    d. WinControl Software
        i. Schedules

a) Each communication control card shall support up to 24 unique weekly schedules out of a total of 1,000 available per system. Each schedule shall allow up to eight events per day for a repeating seven day week.
b) Up to 32 holidays may be defined for any specific date. On that date any of the three holiday schedules may be assigned.
c) Relays may be programmed to switch to a different weekly schedule on any specific date, and then revert back to normal at another time. This allows for future schedule changes to be programmed ahead of time.
d) "Spring Ahead" and "Fall Back" dates for daylight savings time changes may be entered full two years ahead. Software also supports the ability to "Auto fill" in the next two occurrences of each of these dates.

ii. Time Delay / Blink Warning
a) Used during unoccupied periods, assignable for each relay.
i) Time delays from 2 to 1,440 minutes.
ii) Blink Warning: 1-second OFF blink followed by a 5 minute grace period before OFF.
iii) An optional second blink warning one minute before OFF.
b) Operates automatically for all scheduled OFFs and time delay overrides.
c) Occupant overrides may be entered before the blink warning to prevent a scheduled blink and shutdown.

iii. Analog Photocell Configuration
a) Enable any group switch card input (eight per group switch card) to act as an analog input into the panel for use with photocells or other analog devices
b) Select the photocell from list of available types including:
i) Indoor, 0 - 500 foot candles
ii) Indoor, 0 - 50 foot candles
iii) Skylight, 0 - 6000 foot candles
iv) Outdoor, 0 - 200 foot candles
c) Establish trigger parameters for each analog input with:
i) Separate on and off set points
ii) Separate on and off time delays
iii) Load to be controlled by the input

iv. A total of 32 sets of trigger parameters may be established per panel

v. Analog Photocell Monitoring
a) Actual foot candle light levels per photocell and

the current trigger state of the loads may be read using the Operators Software.

vi. Telephone Override
  a) Each relay shall respond to up to eight different telephone override codes. Maximum of 9999 telephone codes can be programmed.

vii. Runtime Counters for Each Relay
  a) Cumulative runtime (up to 31 years) and number of cycles (up to 17 million) since last reset. User re-settable.
  b) Daily runtime for the current day and each of the prior 40 days.
  c) Monthly runtime for current and 14 prior months.

viii. Activity Logs
  a) Store previous relay events including the time, new state, and cause for the change in state.
  b) Annunciate over the dataline and RS232 port when the table is 25%, 50%, 75% and 100% full.

I. Operator's Software
1. User programming and editing may be conducted both online or offline in a Windows based software application.
2. Data shall be entered through a simple menu-driven user interface.
3. The software shall simplify integration with other software products by allowing the lighting control manufacturer's components to be embedded into other Windows applications. These features shall include the following:
   a. BACnet connectivity with optional WebLink.
   b. Drag and Drop interface programming supported throughout the program.
4. Basic operating software provides the following:
   a. Site wiring documentation for all connected relay panels and system components.
   b. English descriptions of each relay's circuit designation, circuit description, switch and calculated load.
   c. RS232 and TCP/IP Connection to Lighting Control Panel
   d. Monitor/Control all relays. Software shall show actual relay states, with an optional menu showing how and when the relay state occurred, and when next scheduled to change.
   e. Simulate all functions.
5. System Parameters
   a. System software to be sized based appropriately for the system – 250, 500, 750 or unlimited relays. Any number of sites may be programmed from a single software package (based on hard drive space).
   b. Passwords Matrix Features allowed per site.
   c. User defines functions accessible for each password (Document, Program, Initialize, Transfer from PC, Transfer to PC, Control, Simulate/Test).
   d. Configure software to automatically contact remote sites using a modem or I/P address.
6. Other Features
   a. Online help brings up a context sensitive help screen.
   b. One step menu option to back up all site information to a backup drive.

c. The software shall include Trends and Relay Runtime Analysis that will allow the operator to analyze the operation of specific areas and identify those exceeding normal runtimes. Individual relays may be assigned a kWh weighted value or simply analyzed on a runtime basis. In both cases, the relays may be assigned to logical groups and plotted for the last 30 days or 12 months.

7. System Design Capability
   a. From the lighting control system software database, the software shall be able to automatically create a system single line Drawing, panel schedules and Specifications that can be exported in DXF format for use in standard CAD Drawings.

J. Central Programming, Monitoring, and Control Work Station
1. Desktop Computer (PROVIDED BY OWNER) work station will provide monitoring, programming and control of the system.
2. The computer will be a Pentium 4 class personal computer with monitor for enhanced color graphics display. The system shall be shipped complete with all memory, cables, and peripheral devices. The complete system shall be factory tested prior to shipment. The system shall include at a minimum:
   a. 3 GHz, Intel Pentium 4 based personal computer
   b. 17” SVGA flat panel color monitor
   c. 60 GB hard disk
   d. 256 MB RAM
   e. CD +R/+W drive
   f. Lighting control software, WinXP Pro

K. Ethernet Multi-user Connectivity - Weblink
1. System Description
   a. A network appliance will provide multi-user, simultaneous access to the lighting system using standard TCP/IP and the WinControl software.
   b. All IT infrastructure that is required for connectivity shall be specified elsewhere and is not considered part of the lighting control system requirements.
   c. The network appliance will include the following hardware:
      i. Ethernet, Serial and Parallel port
      ii. Optional 56K BAUD internal modem
      iii. Video graphics card

2. Features
   a. Multiple users (each with a licensed copy of WinControl) will be able to simultaneously connect to the IP address of the WebLink.
   b. Users may be connected via an Intranet, or Internet depending upon network security limitations.
   c. Provide the capability to monitor the status of each relay and to override each relay using only a web browser
   d. A single user may connect using WinControl, via the internal modem of the WebLink.
   e. The WebLink will provide all the features of a direct connected site to the simultaneous users.
3. BACnet Integration with Building Automation System

a. Provide an Ethernet or BACnet IP connection for connectivity to the BAS
b. Each lighting control panel shall be exposed to the BAS as a BACnet Device with an individual BACnet Device ID.
c. The lighting control relays within each panel shall be exposed as BACnet Binary Output objects with read/write capability for control and status monitoring.
d. System group codes shall likewise be exposed as Binary Output objects and shall provide capability for a single command from the BAS to control multiple relays in multiple panels simultaneously via the lighting control network.
e. To facilitate a seamless integration with the BAS, the BACnet object Description Property fields shall be automatically populated with the relay, group code, and panel text descriptions from the lighting control system database as created by the WinControl software.

L. Digital Dataline Switches
1. Intelligent digital switching shall be provided operating on the dual twisted pair communication wire. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single-gang box, the octal version in a two-gang box.
a. Each button shall be individually programmable. Programming of buttons shall not require the use of a computer or other programming device. It shall be possible to assign relays or channels to buttons using a simple button press interface. Each button can control any one of the following options:
i. Any individual relay in any single panel.
ii. Any group of relays in any single panel.
iii. Any group of relays in the system (via network clock, Automation Appliance, or WinControl software package).
b. For applications that require pattern switching, buttons shall function as a scene control using an ON/OFF/Not Controlled pattern of relays instead of the normal All ON/OFF.
c. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screw-less Lexan wall plate.
d. Individual buttons shall have a removable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads.
e. Each switch shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.
f. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.
g. Multiple dataline switches programmed to control the same relay or relay group shall indicate the same status automatically.
h. Each switch shall also include a locator light illuminating the switch for easy location in the dark.

i. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch's master button configuration can be altered to perform a Master ON/OFF, OFF Only, or Disabled function if desired.

j. Switches can be configured to follow a "Cleaning" scenario. This specific scenario shall prevent the cleaners from overriding OFF any relays previously turned ON by an occupant.

k. Each switch is available in a Key lock override version. Once a key is inserted, the individual buttons will function for five minutes.

M. Occupancy Sensors

1. Product Numbers:
   a. Ceiling sensors: WT-605, WT-600, WT-1105, WT-1100, WT-2205, WT-2200, WT-2250, WT-2255, W-500A, W-1000A, W-2000A, W-2000H, UT-300, UT-305, UT-355, WPIR, DT-200, DT-205, DT-300, DT-305, DT-355, CX-100, CX-105, CI-200, CI-205, CI-300, CI-305, CI-355, CI-12, CI-24
   b. Wall switch sensors: PW-100, PW-100-24, PW-200, WS-250, WD-170, WD-180, WD-270, WD-280, WN-100-120, WN-100-277, UW-100, UW-100-24, UW-200, DW-100, DW-100-24, DW-200.
   c. Power and Auxiliary Packs: BZ-50, BZ-150, C120E-P, C277E-P, S120/27-P, AT-120, AT-277
   d. Low Temperature: CB-100
   e. Digital Time Switches: TS-400, TS-400-24
2. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
3. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180˚ coverage capability.
4. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
5. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
6. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
7. Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.
8. Passive infrared sensors shall utilize Pulse Count Processing and Detection Signature Processing to respond only to those signals caused by human motion.
9. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
10. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
11. Where specified, passive infrared ultrasonic and dual technology sensors

shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.

12. Dual technology sensors shall be wall mounted, corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas.
13. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
14. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
15. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within ± 0.005% tolerance, 32 kHz within ± 0.002% tolerance, or 40 kHz ± 0.002% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
16. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
17. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
18. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
19. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
20. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
21. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
22. All sensors shall have UL rated, 94V-0 plastic enclosures.
23. Circuit Control Hardware - CU
    a. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of two (2) sensors.
    b. Relay Contacts shall have ratings of:
       13A - 120 VAC Tungsten
       20A - 120 VAC Ballast
       20A - 277 VAC Ballast
    c. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
    d. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

N. Classroom Lighting Controls

1. The Lighting Control and Automation system as defined under this Section covers the following equipment:
   a. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
   b. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   c. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
   d. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
   e. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
2. Digital Wall or Ceiling Mounted Occupancy Sensor System
   a. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
   b. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
      i. Digital calibration and pushbutton programming for the following variables:
         Sensitivity – 0-100% in 10% increments
         Time delay – 1-30 minutes in 1 minute increments
         Test mode – Five second time delay
         Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
         Walk-through mode
         Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
      ii. One or two RJ-45 port(s) for connection to DLM local network.
      iii. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
      iv. Device Status LEDs including:

PIR Detection
Ultrasonic detection
Configuration mode
Load binding

v. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
vi. Manual override of controlled loads.

c. Units shall not have any dip switches or potentiometers for field settings.
d. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
e. Product Numbers: LMPX, LMDX, LMPC, LMUC, LMDC

3. Digital Wall Switches
a. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; white; compatible with wall plates with decorator opening. Wall switches shall include the following features:
i. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
ii. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
iii. Red configuration LED on each switch that blinks to indicate data transmission.
iv. Blue Load/Scene Status LED on each switch button with the following characteristics:
Bi-level LED
Dim locator level indicates power to switch
Bright status level indicates that load or scene is active
v. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
vi. Two RJ-45 ports for connection to DLM local network.
vii. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
viii. The following switch attributes may be changed or selected using a wireless configuration tool:
a) Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
b) Individual button function may be configured to Toggle, On only or Off only.
c) Individual scenes may be locked to prevent unauthorized change.
d) Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
e) Ramp rate may be adjusted for each dimmer switch.
f) Switch buttons may be bound to any load on a room controller and are not load type dependent;

each button may be bound to multiple loads.

ix. Product Numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

4. Room Controllers

a. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:

i. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

ii. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.

iii. Device Status LEDs to indicate:
Data transmission
Device has power
Status for each load
Configuration status

iv. Quick installation features including:
a) Standard junction box mounting
b) Quick low voltage connections using standard RJ-45 patch cable

v. Plenum rated

vi. Manual override and LED indication for each load

vii. Dual voltage (120/277 VAC, 60 Hz)

viii. Zero cross circuitry for each load.

b. On/Off Room Controllers shall include:

i. One or two relay configuration

ii. Efficient 150 mA switching power supply

iii. Three RJ-45 DLM local network ports

iv. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
One relay configuration only
Automatic-ON/OFF configuration

v. Product Numbers: LMRC-101, LMRC-102, LMPL-101

c. On/Off/Dimming enhanced Room Controllers shall include:

i. Real time current monitoring

ii. One, two or three relay configuration

iii. Efficient 250 mA switching power supply

iv. Four RJ-45 DLM local network ports.

v. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.

vi. The following dimming attributes may be changed or selected using a wireless configuration tool:
Establish preset level for each load from 0-100%
Set high and low trim for each load
Set lamp burn in time for each load up to 100 hours

vii. Discrete model listed for connection to receptacles, for

occupancy-based control of plug loads within the space.
One relay configuration only
Automatic-ON/OFF configuration

viii. Product Numbers: LMRC-211, LRMC-212, LRMC-213

5. Digital Photosensors
   a. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.
   b. Digital photosensors include the following features:
      i. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
      ii. Sensor light level range shall be from 1-10,000 footcandles (fc).
      iii. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
      iv. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
      v. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
      vi. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
      vii. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
      viii. Red configuration LED that blinks to indicate data transmission.
      ix. Blue status LED indicates test mode, override mode and load binding.
      x. Recessed switch to turn controlled load(s) ON and OFF.
      xi. One RJ-45 port for connection to DLM local network.
      xii. An adjustable head and a mounting bracket to accommodate multiple mounting methods and Building

materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

c. Open loop digital photosensors include the following additional features:
   i. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
   ii. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
   iii. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
   iv. Product Number: LMLS-500.

6. Room Network (DLM Local Network)
   a. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a Building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
      i. Plug n’ Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
      ii. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
      iii. Push n’ Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
      iv. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

O. Configuration Tools
   1. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Provide two (2) handheld commissioning tools, one (1) for Electrical Subcontractor, one (1) for Owner.
   2. Features and functionality of the wireless configuration tool shall include:
      a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
      b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
      c. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall

switches.

d. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.

e. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.

f. Adjust or fine-tune daylighting settings established during auto-commissioning and input light level data to complete commissioning of open loop daylighting controls.

3. Product Numbers: LMCT-100 DLM.

P. Category 5E Cable

1 Category 5e cable shall be provided by lighting control manufacturer.

Q. Emergency Lighting Control Panel

1. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass if relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 – Article 700.

R. Support Services

1. System Start Up and Commissioning

a. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components. The startup requirement is intended to verify:

i. That all occupancy and daylighting sensors are located, installed, and adjusted as intended by the factory and the contract documents.

ii. The occupancy sensors and daylighting sensors are operating within the manufacturer's Specifications.

iii. The sensors and relay panels interact as a complete and operational system to meet the design intent.

b. Manufacturer to provide a written statement verifying that the system meets the above requirements.

2. System Training

a. Manufacturer shall provide factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system including all occupancy sensors and daylighting controls.

3. System Programming

a. Manufacturer shall provide system programming including:

i. Wiring documentation.

ii. Switch operation.

iii. Operating schedules.

2.30 SURGE PROTECTIVE DEVICES (SPD's)

A. Scope

1. The Electrical Subcontractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Drawings. To maximize performance and reliability and to obtain the lowest possible

let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment; switchboard emergency panelboards, optional standby emergency panelboards, and the computer panelboards.

B. References
1. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

C. Submittals – For Review/Approval
1. The following information shall be submitted to the Engineer:
   a. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
2. Where applicable the following additional information shall be submitted to the engineer:
   a. Descriptive bulletins
   b. Product sheets

D. Submittals – for Construction
1. The following information shall be submitted for record purposes:
   a. Final As-Built Drawings and information for items listed shall incorporate all changes made during the manufacturing process.

E. Qualifications
1. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
2. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

F. Manufacturer's
1. Eaton / Cutler-Hammer products, Current Technologies, Liebert, or equal.
2. The listing of specific manufacturer above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturer listed above is not relieved from meeting these Specifications in their entirety.

G. Voltage Surge Suppression - General

1. Electrical Requirements

a. Unit Operating Voltage – Refer to Drawings for operating voltage and unit configuration.

b. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.

c. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the switchboard and computer panelboards. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

d. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

e. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

f. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

2. SPD Design

a. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

c. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for

electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this Specification shall not be accepted.

d. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

e. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

i. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

a) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

b) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

c) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

ii. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

iii. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

iv. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to

prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

a) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

f. Overcurrent Protection

i. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

g. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

h. Safety Requirements

i. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

H. System Application

1. The SPD applications covered under this Section include the switchboard, emergency panelboards, optional standby emergency panelboards, and the computer panelboards assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

2. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Switchboard	250 kA	125 kA
A	Computer Panelboards	120 kA	60 kA
A	Emergency Panelboards and Optional Standby Emergency Panelboards	120 kA	60 kA

3. SPD Type – All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

I. Switchboard, Emergency Panelboards, Optional Standby Emergency Panelboards, and the Computer Panelboards Requirements

1. The SPD application covered under this Section includes computer panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   a. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   b. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   c. The panelboard shall be capable of re-energizing upon removal of the SPD.
   d. The SPD shall be interfaced to the panelboard via a direct bus bar connection.
   e. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
   f. The SPD shall be of the same manufacturer as the panelboard.
   g. The complete panelboard including the SPD shall be UL67 listed.

2. Switchboard Requirements
   a. The SPD application covered under this Section is for the switchboard location. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
   b. The SPD shall be of the same manufacturer as the switchboard.
   c. The SPD shall be factory installed inside the switchboard at the assembly point by the original equipment manufacturer.
   d. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
   e. The SPD shall be integral to switchboard as a factory standardized design.
   f. All monitoring and diagnostic features shall be visible from the front of the equipment.

J. Factory Testing

1. Standard factory tests shall be performed on the equipment under this Section. All tests shall be in accordance with the latest version of NEMA and UL standards.

K. Installation

1. The Electrical Subcontractor shall install all equipment per the manufacturer's recommendations and the Drawings.

L. Warranty

1. The manufacturer shall provide a full ten (10) year warranty from the

date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable National or Local Code.

2.31 THEATRE AND STAGE EQUIPMENT

A. The Electrical Subcontractor shall be responsible for the following:
1. Install theatrical lighting equipment as furnished by Section 11 61 00.
2. Provide all wiring and conduit to connect all theatrical lighting equipment as furnished by Section 11 61 00.

B. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Theatre and Stage Equipment Integrator, Section 11 61 00 as specified.

1. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes, pathways, power, cableways and J hooks to facilitate a neat and orderly installation of cables, cable protection, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves, shall be brought to an accessible hallway ceiling or accessible area below floor), back boxes, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots, where cables pass from one location to another, removal and re-installation of ceiling tiles to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the Theatre and Stage Equipment Integrator. The Electrical Subcontractor shall install all specialized back boxes.

2.32 SHORT CIRCUIT/COORDINATION/SELECTIVE COORDINATION STUDY

A. The Study shall be conducted by the switchgear manufacturer.

B. The Study work shall be conducted under the applicable Standards of the American National Standards Institute (ANSI) and the National Electrical Code (NEC). Specifically, the following standards shall apply:

ANSI-C37.010-1972 Standard Application Guide for AC High Voltage Circuit Breakers.

ANSI-C37.5-1969 Calculation of Fault Currents for Application of Power Circuit Breaker Rated on a Total of Current Basis.

ANSI-C37.13-1963 Low Voltage AC Power Circuit Breakers (600 Volt Insulation Class).

C. The basic scope of the Study is the power system, from the power supplier’s service point, through the main secondary distribution system. The studies

organization shall identify in its proposal the limits of the system that will be studied.

D. The Study organization shall prepare a single-line diagram of the power system. This diagram shall identify all components considered in the Study and the ratings of all power devices. (This includes, but is not limited to, transformers, circuit breakers, relays, fuses, busses and cables). Reference numbers shall be used on the diagram related to key items in the report. ANSI device function numbers shall be used on protective relays.

E. Short Circuit Study:
1. A Short Circuit Study shall be performed which shows the momentary and interrupting fault duties on each bus shown on the single line diagram. A computer shall be used to perform calculations on all 3 phase faults. In addition, an impedance listing shall be prepared showing bus-to-bus impedance values reduced to a common MVA base referenced to a single-line diagram for ease in reviewing data.
2. Study each fault interrupting device related to the calculated duty and recommend changes when appropriate.
3. The Study shall start from utility incoming switches and shall extend through to all panelboards.

F. Coordination and Selective Coordination Study
1. The Study organization shall perform a comprehensive protection device coordination and selective coordination Study covering all devices identified on the single line diagram. Using a practical compromise between protection of electrical equipment and coordination of devices “downstream”, provides settings for all adjustable protective devices shown on the diagram. Selective coordination Study shall be provided as per National Electrical Code Article 700.
2. Study the application of devices versus system ends and recommend new or additional devices that are needed for adequate protection.
3. Prepare time/current coordination curves to illustrate the protection and coordination achieved with the recommended settings of protective devices. These curves shall reflect the following (where applicable):
   Appropriate NEC protection points
   Appropriate ANSI protection points
   Magnetizing in-rush points of transformers
   One-line diagram of the system identifying the device plotted
   Short circuit current levels used for construction

G. The Study organization shall submit three (3) bound copies of a report which shall contain the following information:
1. An executive summary which identifies all significant problems and all recommendations for significant equipment changes.
2. A tabulation of all protective devices identified on the one-line diagram which their ratings compares with respective fault duty as calculated in the Study.
3. A tabulation of the settings recommended on all adjustable protective devices with references to the single-line diagram and to coordination curves.
4. Copies of all time/current coordination curves developed in the Study.
5. The analysis of problems that lead to specific recommendations included

in the executive summary.

6. The single-line diagram of the system studies, including all ratings, identifications described.
7. Copies of all computer results referenced to the single-line diagram and the impedance listings.
8. A ground fault Study for all breakers specified with ground fault, including the associated zero sequence impedance diagrams.

H. Short circuit and ground fault Study shall be submitted with panelboard Shop Drawings to verify that available fault currents fall within panelboard/ breaker ratings. Coordination Study may follow, but shall be submitted with the switchboard Shop Drawing.

I. Necessary field studies shall be accomplished at no additional expense to the contract.

2.33 MINERAL INSULATED METAL SHEATHED CABLE (MI CABLE)

A. Section Includes
1. Type MI mineral-insulated seamless metal sheathed cable.
2. Cable connectors and connections.

B. References
1. ANSI/NFPA 70 - National Electrical Code; UL 2196.

C. Submittals
1. Product Data: Provide for each cable assembly type.
2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

D. Qualifications
1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years documented experience and manufactured in North America.
2. Cable shall not off gas or propagate smoke.

E. Regulatory Requirements
1. Conform to requirements of ANSI/NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc. As suitable for purpose specified and shown.

F. Project Conditions
1. Verify that field measurements and conditions are as shown on Drawings.
2. Cable routing shown on Drawings is approximate unless fully dimensioned. Route cable to meet project conditions.
3. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

G. Coordination
1. Coordinate work specified in this Section with work provided under other electrical work and the work of other trades.
2. Determine required separation between cable and other work.

3. Determine cable routing to avoid interference with other work.

H. Manufacturer's – Mineral-Insulated Metal-Sheathed Cable
   1. Tyco Thermal Controls/Pyrotenax System 1850 2-hour fire rated, or equal.

I. Mineral-Insulated Metal-Sheathed Cable
   1. Description: ANSI/NFPA 70, Type MI
   2. Conductor: Copper
   3. Insulation Voltage Rating: 600 volts.
   4. Cable Temperature Rating: 75 degrees C.
   5. Termination Temp. Rating: 90 degrees C.
   6. Insulation Material: Magnesium oxide refractory mineral.
   7. Metal-sheath Material: Seamless soft drawn copper.
   8. Fire Rating: Cable assembly including supports shall have a 2-hour fire rating as listed and classified by Underwriters Laboratories, Inc.
   9. Over jacket is available.

J. Wiring Connectors and Terminations
   1. Cable Termination:
      a. Tyco Thermal Controls/Pyrotenax Model Quick-Term Installation Sheet 638. (Solid M.I. conductor to approved solid rated lug is also available as a slight variation to the Quick-Term Termination.)

K. Examination
   1. Verify that cable end factory temporary seals have remained intact, that the insulation has not been exposed to air, and that no moisture has entered cable insulation.
   2. Verify that work of other trades likely to damage cable has been completed

L. Storage
   1. Cables shall be shipped from the manufacturer with ends temporarily sealed against moisture ingress.
   2. When cables are cut in the field, the end shall be sealed using standard sealing compound and PVC tape
   3. Cable shall be stored in a clean dry location.

M. Handling
   1. Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or center
   2. Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign material or sheaves.

N. Wiring Methods
   1. Fire Rated Locations: Use only fire rated cable.
   2. Use wiring methods indicated on Drawings and as specified herein.

O. Installation
   1. Install products in accordance with manufacturer's instructions.
   2. Bending:
      a. Not less than five (5) times the cable diameter for cable not more

than ¾ inch (250 kcmil).

b. Not less than ten (10) times the cable diameter for cable more than ¾ inches (350 and 500 kcmil).

3. Pulling:
   a. For all cables up to and including #1 AWG use 24 inch (250mm) or larger sheaves.
   b. For #1/0 through 250 kcmil inclusive, use 18 inch (460mm) or larger sheaves.
   c. For 350 kcmil and larger cables, use 24 inch (610mm) or larger sheaves.
   d. On pulls of over 360 degrees, contact manufacturer for assistance.
   e. 350 and 500 kcmil cables shall not be pulled more than 360 degrees in total.
4. Splicing: All fire rated splices shall be made in the factory.
   a. In the event a field splice is necessary, it must be approved by the engineer and made in field by personnel trained by cable manufacturer using manufacturer's components.
5. Terminations:
   a. Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.
   b. Terminations must be completed immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level.
   c. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates ¼ inch (6mm) thick by 4 inch (100mm) wide by proper length with ½ inch (12mm), ¾ inch (19mm), 1 inch (25mm) or 1-1/4 inch (32mm) drilled and tapped holes. Install per manufacturer's' Drawing.
   d. For applications using 90 degree C rating of cable, lugs shall be rated 90 degrees C.

6. Sheath Induction Reduction:
   a. When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group.
   b. Each set of paralleled conductors shall be separated by at least 2.15 single cable diameters.
   c. On balanced three-phase wye circuits neutral conductors may be located within the 2.15 cable diameter space between groups of phase conductors.
   d. Each group of cables shall be fastened tightly together, at least once between each cable support on horizontal runs and twice on vertical runs, using ½ inch (13mm) wide by 0.030 inch (0.75mm) thick stainless steel straps.

7. Exposed of Surface Installations:
   a. Cable may be secured directly to fire rated Building structure using an approved method such as one, or any combination, of the following:

i. Straps: ½ inch (13mm) wide x 3-1/2 inch (90mm) long by 0.030 (0.75mm) thick stainless steel or copper straps. Each strap shall contain two ¼ inch (6mm) holes for securing with 3/16 inch (5mm) by minimum 1-3/4 inch (44mm) long steel anchors.

ii. Steel struts and cable tray: Use only the steel strut framing system and support recommended by Pyrotenax. Aluminum or other materials are not acceptable.

iii. Other approved method.

b. Supports shall not exceed six (6) feet on center horizontally, or six (6) feet vertically.

c. Cables shall be installed parallel to Building lines.

8. Embedded Installations:
   a. Cables will be run in the same trifoil configuration as exposed installations.
   b. Protect against damage during pulling, and during concrete pouring or backfill and tamping.
   c. Where cables emerge from grade, provide PVC conduit, metal plate or angle iron. This protection shall minimally extend from 18 inches (460mm) below grade to 8 ft. (2.5m) above grade.
9. Wall or Floor Penetrations:
   a. Provide sleeve to protect cable and penetration opening during pulling.
   b. Provide approved fire stopping of all penetrations.
10. Neatly train and lace cable inside boxes, equipment, and panelboards.

P. Field Quality Control
1. Inspect cable for physical damage and proper connection.
2. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
3. Verify continuity of each conductor.
4. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval.

2.34 FANS (DESTRATIFICATION)

C. Provide as shown on the plans, non-power overloading ceiling mounted destratification fan(s). Fan(s) shall be of the specified size, arrangement and capacity. Fan(s) having tip velocities greater or requiring horsepower greater than those identified as the Project Standard will not be acceptable.

D. The fans shall bear the AMCA certified ratings seals for both air and sound performance. Fan ratings shall be based upon tests performed in strict accordance with AMCA Standard 210-67 test code for air moving devices. Each fan shall carry near the manufacturer's nameplate, the seal authorized by AMCA indicating that ratings are certified. Fans not bearing this seal will not be acceptable.

E. Each fan shall have tagging identification engraved on the manufacturer's nameplate. Units shall be manufactured by Leading Edge No. 5620-1, or equal as manufactured by Cook or Peerless.

F. Propeller Criteria:

1. Blades diameter shall be 56" and shall be constructed of die formed, aerodynamically contoured steel. Each blade shall have a high tensile steel bracket spot welded in a minimum three (3) point suspension formation, ground smooth following assembly. Bracket shall anchor its blade to the motor rotor assembly using a minimum of two (2) machine screws to support maintainability.
2. Blades shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer, color white. Blade sets shall be weight matched to within two (2) grams tolerance and shall be statically and dynamically balanced following the coating and assembly processes.
3. Fans to be installed less than ten feet (10') above the floor shall have rolled edge blades a minimum of 3/16 inches in thickness in conformance with U.L. Standard 507.

G. Motor Criteria:

4. Each fan motor shall be sized to drive its fan. Whenever starting requirements exceed operating requirements, the motor shall be selected large enough to start the fan without overheating.
5. No motor shall operate within the service factor range.
6. Motor shall be of the heavy duty, fixed shaft-rotating housing type carefully matched to the fan load. Motor shall be premium efficiency, 0.91 minimum power factor, poly-phase or single phase as identified on the Drawings.
7. Motor shall be suitable for use with solid state motor speed controllers. Provide embedded automatic-reset type thermal overload protection. Fans to be so labeled in accordance with U.L. Standard 507.
8. Motor shaft shall be steel bar rod, cold-drawn, minimum 5/8 inches in diameter. Shaft shall incorporate the necessary holes to incorporate down-rod assembly mounting and secondary safety cable mounting simultaneously.

H. Bearings:

9. Bearings shall be of the self-aligning, heavy duty, permanently sealed and greased chrome steel ball type.
10. The bearings shall be of sufficient size and quality to have AFBMA B50 rated lives in excess of 100,000 hours at maximum cataloged fan operating conditions.

I. Motor rotor/housing assemblies shall be of formed steel construction, deep drawn to provide air space for motor heat dissipation. Housing shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer.

J. Down-rod Assembly:

11. Down-rod assembly shall consist of 3/4 inch nominal outer diameter steel pipe finished in epoxy enamel finish over electro-statically applied epoxy powder primer.

12. Upper shackle shall secure directly to the down-rod, shall consist of nominal 1/8 inch thick formed, plated steel, and shall be rubber bushed to provide a resilient floating suspension for the mounting hook.
13. Lower yoke shall secure directly to the down-rod and shall consist of nominal 1/8 inch thick formed, plated steel. Yoke shall provide primary support directly to the motor shaft and shall provide space for the secondary support cabling.

K. Fan accessories shall include:

14. Factory installed secondary support assembly connected to motor shaft with minimum six (6) feet of 1/8 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
15. Totally enclosing fan guard of twelve (minimum) spoke across bar construction:
    a. Radial Bars – 5 gauge.
    b. Circumferential Bars – 5 gauge on three (3) inch centers.
    c. Heavy duty 16 gauge mounting brackets shall secure the fan guard assembly directly to the fan down rod assembly. Provide a secondary support assembly connected to fan guard mounting brackets with minimum six (6) feet of 3/32 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
16. U.L. listed solid state motor speed controller shall incorporate infinite speed control with positive “Off” position. Controller shall incorporate 8 ampere rated (minimum triacs and solid copper wire toroidal choke-type RFI suppression circuitry.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All equipment mentioned in these Specifications or those on the Drawings shall be furnished new except where noted and completely installed and adjusted and left in a clean, safe and satisfactory condition, ready for operation and all supplies, appliances, and connections of every sort and description necessary to the operation of the equipment shall be furnished and installed to the satisfaction of the Architect and Owner.

B. The Owner will not be responsible for materials and equipment until they have been tested and accepted.

3.2 CLEANING, ADJUSTING AND TESTING

A. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All devices, equipment, conduits, and fittings shall be completely cleaned of grease, metal cuttings, dirt which may have accumulated during construction, and protection covers. Any discoloration or damage to parts of the Building, its finish or furnishings due to failing to properly clean the electrical system shall be repaired by the Electrical Subcontractor without cost to the Owner.

B. The Electrical Subcontractor shall test all work and equipment as directed by the Architect and by Authorities Having Jurisdiction, furnish all equipment, necessary personnel and the electrical power.

C. The entire installation shall be tested for shorts, grounds and open circuits and all defects shall be corrected before acceptance of his work. All work shall be demonstrated to be in proper operating condition to the complete satisfaction of the Architect and Owner.

D. Coordinate all start up, operation and testing activities with the Project Manager, General Contractor and the Commissioning Agent per Specification Section 01 91 00.
   1. Electrical Subcontractor tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specification, Section 01 91 00, for further details.
   2. System verification testing is part of the Commissioning Process. Verification testing shall be performed by the Electrical Subcontractor and witnessed and documented by the Commissioning Agent. Refer to Commissioning Specification, Section 01 91 00, for system verification tests and commissioning requirements.

3.3 SLEEVES, INSERTS AND SUPPORTS

A. The Electrical Subcontractor shall lay out and install his work in advance of the pouring of concrete floors and walls.

B. Furnish and install all inserts, conduit hangers, anchors and steel supports necessary for the support and installation of all electrical equipment.

L. Where openings are required in walls and floors for the passing of raceways, ducts or busways, the Electrical Subcontractor shall furnish the General Contractor with the necessary information regarding dimensions and locations so that he may install suitable concrete stops to provide these openings. Such openings shall be by the General Contractor in such a manner so as not to interfere with the fireproof integrity of the Building.

M. The Electrical Subcontractor will be held responsible for the location of and maintaining in proper position, sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event that failure to do so requires cutting and patching of finished work, such work shall be done at the Electrical Subcontractor's expense by the General Contractor.

3.4 EQUIPMENT CONNECTIONS

A. The Electrical Subcontractor shall provide all connections to all equipment requiring electrical service, including power cables, branch circuit extensions, fire alarm cables, motors, controllers, lighting fixtures and all other equipment and systems specified or shown on the Drawings.

3.5 MOTOR AND CONTROL WIRING

A. The Electrical Subcontractor shall provide all wiring, including conduit, wire, junction boxes, disconnecting switches, and overcurrent protection, to and between all motors, starters, control devices and related electrical equipment whether specified or shown under Division 26 00 00 or other Divisions, except where such items are factory wired as well as factory mounted on the driven

equipment.

B. Unless otherwise specified, the Electrical Subcontractor shall mount and align all starters, control devices, safety switches, power factor correction capacitors and other related electrical equipment whether specified in this or other Divisions of this Specification, except where such items are factory mounted on the driven equipment. The Electrical Subcontractor shall determine the correct rotation of any equipment connected to a polyphase motor and connect motor for this rotation before equipment is started.

C. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment shall run in rigid conduit or EMT, with flexible metal conduit connections or liquid- tight flexible connections where specified elsewhere. Conduits shall be large enough to accommodate motor branch circuits and grounding conductors whether or not so indicated on Drawings. Wire sizes shall be as shown or to comply with the National Electrical Code.

3.6 HVAC WIRING

A. Wiring for low voltage temperature control equipment is included under Division 23.

3.7 CONCRETE WORK

A. The General Contractor shall provide concrete work for site lighting pole bases.
B. The General Contractor shall provide duct and conduit envelopes and pads for electrical equipment. The General Contractor shall provide 4” concrete pads for all floor mounted electrical distribution equipment.

C. The Electrical Subcontractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

3.8 GROUNDING

A. Grounding methods shall be in accordance with the Massachusetts Electrical Code Article 250 and Local Utility Company Regulations.

B. Furnish and install from the main service switch to the street side of the water meter a stranded copper grounding conductor in rigid steel conduit. If the water service pipe is of material which is not electrically conductive, furnish and install approved copper plates or rods buried and grounded below grade, to which the main service grounding conductor shall be connected.

C. Connections to the water pipe shall be made by a suitable ground fitting or lug connection to a plugged tee.

D. The required equipment grounding conductors and straps shall be sized in compliance with National Electrical Code and shall be provided with green insulation equivalent to the insulation on the associated phase conductors.

E. Flexible metallic conduit equipment connections utilized in conjunction with branch circuits shall be provided with suitable green insulated grounding conductors connected to approved grounding terminals at each end of the flexible conduit.

F. The neutral conductor of all circuits shall have an identifying marking preferable a covering of white, readily distinguishable from the other conductors. This wire shall be unbroken from the distribution switch to the outlet.

G. Each Electrical expansion fitting shall be provided with a bonding jumper.

H. Ground metal frame of Building. Where metal of frame of Building cannot be grounded, provide concrete encased electrode as per National Electrical Code.

3.9 CONDUIT WORK

A. All wiring shall be installed in heavy wall rigid steel unless otherwise noted below and run concealed except as indicated on the Drawings. Branch circuit wiring in hung ceilings, furred spaces or exposed may be installed in electrical metallic tubing. Panelboard feeders may be run in electrical metallic tubing except panelboard feeders run underground or in concrete slabs shall be in heavy wall rigid steel conduit as specified above or PVC. All exposed conduit in spaces indicated as mechanical rooms and where installed exposed below the 8' level elsewhere on the project shall be rigid steel conduit. Conduit extensions in metal partitions may be made with flexible metal conduit, with grounding conductor.

B. Connections to portable and permanently mounted motorized equipment and motors, as well as the equipment housing, shall be made with approved liquid tight flexible metal conduit. Flexible connections shall be a maximum of 18” long and with grounding conductor. Flexible connections shall be used prior to attachment to equipment housings.

C. Conduit ends shall be cut square, threaded and reamed to remove burrs and sharp edges. Field threads shall be of the same type and have the same effective length as factory cut threads. Excessive exposed threads will not be allowed. Turns, wherever required in exposed conduit runs shall be made by the use of factory-made bends, or field made bends. Condulets, or in the event of a multiplicity of conduits making the same turn, a steel junction box with a removable steel cover may be used. Offsets and bends for changes in elevation of exposed conduit runs shall be made at walls or beams and not in open spaces between walls or beams. Conduits shall be routed so as not to interfere with the operation of maintenance of any equipment. The entire job shall be done in a neat and workmanlike manner. Steel supports or racks shall be galvanized steel channel and fittings, Unistrut, Kindorf, Husky Products Company, or equal.

D. All conduit work shall be carefully cleaned and dried inside before the installation of conductors. Wire shall not be pulled into conduit system until Building is completed. Plug conduit ends to exclude dust, moisture, plaster or mortar while Building is under construction. No lubricants or cleaning agents which might have a deleterious effects on conductor coverings shall be used for Drawing conductors into raceways.

E. Drawings, in relation to routing of conduits, are diagrammatic. The number and size of conduits and wire shall be furnished and installed as indicated by the Drawings. Conduits shall be routed in the field so as to be coordinated with the Building structure. Concealed conduit shall be as short and direct as possible. Exposed conduit shall be run in straight lines parallel to walls, beams and columns and with right angle bends and threaded conduit fittings. All conduit in concrete slabs shall be run above bottom steel reinforcing, below top reinforcing and column ties. Conduits passing through floors, walls and beams shall be of

such size, number and in such locations so as not to impair the strength of the construction. At time of roughing conduits in concrete slab area, prior to pouring of slab, the Electrical Subcontractor shall consult the Structural Engineer for coordination and approval of size, spacing and method of conduit installation in slabs and walls, as well as penetration of such. Particular attention shall be given to the installation of conduits at grouped areas, such as panelboard, cabinet and pull box entrances.

F. All metal conduit buried in the earth or fill shall be coated with two coats of heavy asphalt paint over its entire length, including couplings.

G. Raceways in ceiling spaces shall be routed in such an approved manner as to eliminate or minimize the number of junction boxes required, but also shall be routed in an orderly and organized manner. Support rods and clamps shall be furnished and installed as directed by the Architect. Support of conduits by use of wire is strictly prohibited. Conduits shall be supported and secured by conduit support devices.

H. Where rigid metal conduit is threaded in the field, a standard conduit cutting die providing 3/4" taper per foot shall be employed. Threadless coupling shall not be used on rigid metal conduit except where specifically allowed by the Architect. Running threads shall not be used on rigid metal conduit.

I. Conduit work shall be installed in such a manner to keep exposed threads to an absolute minimum, and in no case shall more than three threads be left exposed after the conduit work is made up tight. This requirement applies to all conduit work, including conduit buried in earth or fill or in concrete.

J. Minimum size conduit shall be 1/2" nominal trade size.

K. A minimum 3/16" diameter twisted nylon plastic type fish cord shall be furnished and installed in all empty raceways. Provide a tag on each end of fish cord indicating the location of the other end.

3.10 WIRE AND CABLE

A. Wiring for all branch circuits and feeder circuits shall be color coded as follows:

1. 3-phase, 4-wire, 208Y/120 volts:

Phase	Color
A	Black
B	Red
C	Blue
Neutral	White
Equip. Ground	Green

2. 3-phase, 4-wire, 480Y/277 volts:

Phase	Color
A	Yellow
B	Brown
C	Orange
Neutral	Gray
Equip. Ground	Green

3. Connections to terminal shall be arranged Phase A, B and C from left to right.

4. Signal system shall be color coded differently from electrical systems described above.
5. For large size conductors available only in black, use colored plastic tape at all ends and where connections and splices are made for the specified color code identification. Tape shall be wrapped around the conductor three complete turns.

B. Branch circuits are in general arranged with one neutral conductor serving as "common" for 2 or 3-phase wires. In each case, the phase wires shall be connected to the phase supply mains in proper rotation to assure a balanced condition on the panel, or separate neutrals shall be used. The circuit numbers assigned on the Drawings are used for convenience only and need not designate the circuit on the panel to which that circuit may be connected. However, the circuit numbers and circuit description are required to be typewritten on the panelboard directory at the conclusion of the work, and shall represent the circuits as actually connected to the panelboard.

C. Joints and splices shall be made in an approved manner and shall be equivalent, electrically and mechanically, to the conductor insulation. Solid conductors shall be spliced with approved wiring connectors. Conductors of Size No. 8 AWG and larger shall be connected by use of solderless pressure connectors; these joints and splices shall be taped with one wrap of varnish cambric tape and then a minimum of three wraps of No. 88 Scotchbranch (3M Company) all-weather vinyl plastic electrical tape, or equal Permacel or Plymouth Company. Each wrap of tape shall be half-lapped. Conductors of Size No. 4 AWG or larger shall have two coats of insulating varnish applied over the tape.

D. Switch leg wiring shall be the same color as the phase conductor from which it is supplied.

3.11 INSTALLATION OF OUTLETS

A. If any discrepancy is found to exist between the electrical plans and any other Drawings associated with the project, notify the Architect at once and have location verified before outlets are installed. Any reasonable change in location of outlets and equipment prior to roughing shall not involve additional expense to the Owner.

B. Consult with the Ceiling Subcontractor regarding the centering of outlets in ceiling tile.

C. Whenever outlets of any system are installed in brick, masonry or concrete construction, furnish and install the necessary boxes and conduit in connection therewith so that the General Contractor may build them in as the work progresses. Box offsets shall be made at all outlets to provide for proper adjustment to finished surfaces.

D. Through-wall boxes will not be permitted. Outlet boxes shall not be mounted back to back, but shall be staggered a minimum of 12" on center.

E. Knockouts in any boxes shall not be left open and all boxes not having equipment mounted on them shall be provided with blank covers.

F. Bar hanger type outlets shall be used in hollow framed partitions other than those of the masonry or construction block type, with bar hanger supported from two partition studs. Bar hangers shall be secured to metal type partition studs with self- threading metal screws, or drill through hangers with caddy (or equal) clips shall be used.

3.12 EXTERNAL TELEPHONE SERVICE

A. Furnish and install from utility pole to the Building, as shown on the Drawings, Schedule 40 PVC duct with pull wire for telephone cable installation. Consult with the Telephone Company regarding this service and do all work according to their requirements.

B. The Electrical Subcontractor will be responsible for providing complete telephone service to the Building. Coordinate number of lines required with the Owner prior to installation.

C. The Telephone Company will install the telephone cable to the Building. The Owner will pay for all backcharges incurred by the telephone company.

D. Provide pull strings for entire run of conduit for service cabling from telephone service origination to point of demarcation. Provide pull string for spare conduit.

3.13 EXTERNAL CABLE TV SERVICE

A. Furnish and install from utility pole to the Building, as shown on the Drawings, Schedule 40 PVC duct with pull wire for Cable TV service. Consult with the Cable TV Company regarding this service and do all work according to their requirements.

B. The Electrical Subcontractor will be responsible for providing complete Cable TV service to the Building.

C. The Cable TV Company will install the Cable TV cable to the Building. The Owner will pay for all backcharges incurred by the Cable TV Company.

D. Provide pull strings for entire run of conduit for service cabling from Cable TV service origination to point of demarcation. Provide pull string for spare conduit.

3.14 ELECTRIC SERVICE

A. Consult with National Grid, hereinafter called the Utility Company, with respect to providing service and metering to the Building.

B. Primary Service:
   1. The project shall be served from a utility company pole and shall run underground to a new pad mounted transformer.
   2. Transformer shall be installed on a concrete pad where shown on the Drawings. The exact location for terminating primary and secondary conduit at the transformer shall be coordinated with the Utility Company. All 90° risers into transformer pad shall be rigid galvanized steel conduit.
   3. The Utility Company shall furnish and install primary cable.
   4. Transformer shall be furnished and installed by the Utility Company. Primary connections at the transformer shall be by the utility company.

5. The Electrical Subcontractor shall coordinate all work related to installing the primary services with the Utility Company. The Owner will pay for all backcharges incurred by the Utility Company.
6. The Electrical Subcontractor shall furnish and install an extra Schedule 40 PVC duct from the utility co. pole to the transformer pad as shown on the Drawings.

C. Secondary Service:
1. The Electrical Subcontractor shall furnish and install secondary conduit and cable from the pad mounted transformer to the main disconnecting device. Secondary connections at the transformer shall be by the Electrical Subcontractor. Terminal connectors at the transformers secondary service shall be furnished and installed by the Electrical Subcontractor. Secondary service characteristics shall be 480 volt, three phase, four wire.
2. The Electrical Subcontractor shall coordinate with the Utility Company to ensure the installation of the secondary service shall conform with the Utility Company's requirements.
3. Metering shall be provided at the transformer, by the Utility Company.

D. Division of responsibility with respect to the underground service extension shall be as follows:
1. The General Contractor shall be responsible for the work and materials required for the following:
   a. Excavation.
   b. Backfill.
   c. Transformer pad.
   d. Concrete encasement of conduit.
   e. Resurfacing of grades.
2. All other materials, equipment and labor required for the complete ductbank shall be furnished and installed by the Electrical Subcontractor under this Section, including the following:
   a. Primary and secondary raceways, including handholes.
   b. Grounding system.
   c. Pull strings.

3.15 UNDERGROUND DUCTBANK

A. Furnish and install ductbank as herein specified and as shown on the Drawings. The entire length of ductbank must be inspected and approved by the Utility Company prior to being covered.

B. Materials shall be as follows:
1. Conduit-PVC Schedule 40.
2. Conduit supports (duct system) shall be molded plastic with interlocking lugs and skeletonized structure. Minimum separation 3-1/2 inches.

C. Duct System shall be as follows:
1. The size and number of conduit shall be as indicated on the Drawings.
2. The entire length of ductbank shall be excavated and graded before any conduit is laid.
3. The ductbank shall be set on undisturbed earth.

4. The conduit shall be installed so that the top is a minimum of 36 inches below finished grade.
5. Changes in direction shall be made by long sweep bends. Minimum radius 25 feet except that at the end of a run within 10 feet of termination, manufactured bends may be used having a minimum radius of 36".
6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other but shall be staggered a minimum of 6".
7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered. Minimum space between joints in adjacent conduit shall be 6".
8. When the required number of conduits have been installed, securely tie the assembly together at distances not exceeding 7 feet. Tie shall consist of three turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
9. Where conduit is encased, the duct envelope shall be of monolithic construction.
    a. Pouring of concrete shall be continuous throughout the length of construction. The end of the pour shall be interlocked or sloped. If the installation is halted, the ends of the conduit shall be plugged.
    b. Concrete shall not be poured until the conduit installation has been inspected and approved.
10. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and stiff bristle brush shall be pulled through each conduit. The mandrel shall be not less than 12" long and the diameter approximately 1/4" less than the conduit.
11. Install approximately 12" below the top of the trench above each conduit or direct buried cable a 6-inch wide plastic warning tape. Tape shall be yellow in color with black letters reading "Buried Electric Lines."
12. Electric handholes shall be precast and shall be installed where indicated. The exact location of each handhole shall be determined after careful consideration has been given to the location of other utilities, grading and paving. The location of each handhole shall be approved by the Architect before installation. Handholes shall be a minimum of 4'-0" by 4'-0" by 4'-0" high. Handholes shall be monolithically constructed precast-concrete having the required strength as established by ASTM A 79 Grade 60 and inside dimensions by the Drawings or Specifications. Frames and covers shall be delivered on the job unpainted and, after approval, shall be given two (2) coats of asphalt paint. In unpaved areas, the top of handhole covers shall be approximately 1-2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, provide a brick collar to elevate temporarily the handhole cover to existing grade level. Where duct lines enter handholes, the sections of duct may be either cast in the concrete or may enter the handhole through a square or rectangular opening of suitable dimensions provided in the handhole walls. Where openings are provided for the entrance of duct lines, the space between ducts and between ducts and handhole walls shall be caulked tight with lead wool installed over the handhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance. All handholes shall be

provided with double-lockable type covers.

3.16 FIRE STOPPING

A. Electrical installations in hollow spaces, vertical shafts and ventilation or air handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors or ceilings shall be firestopped using approved methods to maintain the fire-resistance rating. Refer to Section 07 84 00 for Firestopping. All fire stopping material and installation will be by the General Contractor.

3.17 SPECIAL COORDINATION INSTRUCTIONS

A. Coordination with the work of other trades is referred to within various parts of this Section. The following special instructions shall also be carefully noted:
   1. The Electrical Subcontractor shall obtain from the HVAC Engineer copies of all Shop Drawing prints showing the ductwork installation as it will be put in place on the project. These Drawings shall be thoroughly checked by the Electrical Subcontractor and the routing of all conduits and installation of all outlets and electrical equipment shall be coordinated with the ductwork so as to prevent any installation conflict. Such coordination shall be done prior to roughing-in conduits, outlets and electrical equipment.
   2. Locations of all wall outlets shall be verified with the Architect prior to roughing in conduits. Refer to details and wall elevations on the Architectural Drawings; mounting heights indicated on these Architectural Drawings and/or specific dimensional information given to the Electrical Subcontractor by the Architect shall take precedence over such information indicated on the Electrical Drawings.
   3. Refer to all other Drawings associated with this project. Any equipment which requires an electrical supply circuit, switch, controls and connections, even though not indicated on the Electrical Drawings, shall be furnished and installed as directed by the Architect. Locations of lighting fixtures shall conform to the architectural reflected ceiling plans.
   4. Refer to Architectural Drawings for areas in which the concrete slab is poured on grade. In these areas a moisture proofing membrane will be installed on the grade fill or earth prior to pouring of slab. Electrical conduits shall be so installed, where possible, to avoid the necessity of penetrating this moisture proofing membrane. Such penetration of the membrane shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.

3.18 ALTERNATES

A. Refer to Alternates, Section 01 23 00, for alternates affecting the scope of work under this Section.

B. The work of this Section, which is required by the scope of work as stated in the Alternates, Section 01 23 00, shall comply with the applicable quality and performance requirements for similar work under this Section.

C. The alternates which effect the Electrical Sections are:
   1. Alternate No.1 – xxxx.

a. Alternate Number 1: xxxx.

3.19 PROJECT CLOSEOUT

A. A certificate of completion shall be issued by the Electrical Subcontractor indicating that the installation is in conformance with the Construction Documents and all applicable Local, State and Federal Statutes and Codes. Final inspection by the Engineer shall be conducted after receipt of the Certificate of Completion. At minimum, life safety items shall be 100% complete including emergency lighting systems, the fire alarm system, and the emergency standby system before the Electrical Subcontractor request for final inspection. If final inspection by the Engineer proves that the emergency lighting systems, the fire alarm system, and the emergency standby system are not 100% complete, the Engineer will backcharge the Electrical Subcontractor at his hourly rate for re-inspection.

END OF SECTION

Section 27 10 00

STRUCTURED CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all cabling work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows:

1. Fiber Backbone and Fiber distribution cable for video, horizontal Cat 6A, 6 and 5e wiring, connecting devices, terminations, faceplates, patch panels, equipment racks with vertical cabling management and all related equipment, to complete installation, and testing of the systems to be used as signal pathways for voice, high-speed data, wireless access point cabling and CCTV transmission.
2. Copper patch cords for every cabled port in the IDF closets and MDF.
3. Provide and install the following faceplates and jacks: WAP4, WALL PHONE (PH), T1B, V8B, Data face plated (D#), A1 (A1 must have a blank port) A3 (must have 2 extra blank ports for video entry system cable pathway. Coordinate jack required for PA system admin phone with 27 50 00 communications subcontractor. Must be gray in color), A2, F (fax lines), VB and CCTV (C###) (CCTV locations reflect camera locations. Actual data outlet shall be positioned as close as possible to each camera location. For indoor and outdoor surface, corner, pendant and wall mount locations, data outlet shall be installed above the finished accessible ceiling where conduit run terminates from the camera location. All data outlet locations shall be above finished ceilings or other accessible ceiling/wall spaces. For recessed ceiling locations, install data jack as close to camera position as possible in accessible ceiling location. Electrical subcontractor is responsible

for back box to mount camera with 1" conduit to accessible ceiling at every CCTV symbol on drawings (back box at CCTV location is for camera mounting (camera mount back box not required for recessed camera locations), and back box for RJ45 jack near every CCTV camera locations) and any other faceplate and jacks that are reasonably assumed to be primarily for data, wireless, CCTV or voice. CCTV cameras provided by 28 00 00. A1 (or any A faceplate with a PB designation near it) must have blank port for PB cable pass through (Coordinate with 28 00 00),

4. Nameplates, labels and tags for cables and faceplates. Coordinate with Owner.
5. Testing and Certification.
6. Label all Tel/Data conduits that terminate in a room with on both ends (do not label stub ups from faceplates).
7. Label switch end of all IDF/MDF patch cords with originating patch panel letter and port number ie: B-44.
8. All above ceiling WAP4 outlets shall be denoted on the ceiling tile below the outlet with a ½" green dot sticker. Mark location of all CCTV back boxes above ceiling tiles in a similar fashion with a ½" yellow dot sticker. Mark all above ceiling locations for data in a similar fashion with a ½" blue dot sticker.
9. All wall phone back boxes shall be a min of 6" away from any side wall, corner, door jamb or adjacent back box. Wall phone (PH symbol) faceplates shall be stainless steel.
10. Coordinate, provide and install all cabling as coordinated by each communications subcontractor for 27 50 00 and 28 00 00 to complete the work in the following sections: 27 50 00 – Distributed Communications and Monitoring; 28 00 00 – Electronic Safety and Security. All cabling shall comply with the respective sections manufacturer's requirements and shall not void any manufacturer's warranty.
11. Provide and install in all table tops with floor boxes below 2 blue Cat6A pass thru keystone jacks and 1 white Cat6A pass thru keystone jack. Provide and install patch cords (blue for data, white for voice, Cat6A) connecting floor box data ports to pass thru jacks in furniture.
12. All faceplates (except PH faceplates as specified above) shall be white thermoplastic unless specified or noted on the drawings otherwise.

B. The work of this Section is shown on Technology Drawings numbers designated by a T.

C. No corridors, classrooms or spaces are air plenums. No cabling is required to be plenum rated.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27 and Division 28

B. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

C. SECTION 01 23 00 - ALTERNATES

D. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. Specialty Equipment: DIVISION 11, "EQUIPMENT"

2. Field Painting: DIVISION 9, "FINISHES"

3. SECTION 23 00 00- HVAC

4. SECTION 26 00 00 - ELECTRICAL

5. SECTION 22 00 00 - PLUMBING

6. SECTIONS of DIVISION 27 and 28

7. SECTION 12 68 00-SEAT AND TABLE ASSEMBLIES

8. SECTION 14 – ELEVATORS

9. SECTION 08 71 00 – DOOR HARDWARE

E. Unless otherwise indicated, the following work is not included as part of the 27 10 00 Communication Systems Integrator's responsibilities in this SECTION, except for coordination, and is to be performed by others as indicated:

1. Empty conduits for cable pathways to accessible point above finished ceiling or below floor shall be provided by the electrical subcontractor to ensure distance limitations of cables as determined by standards. Coordinate with RCDD of this section and notify architect of any discrepancies.

2. Cable tray, provided by the electrical subcontractor, shall be a black and a minimum of 20" wide by 6" high. All cable tray shall be within 10" above racks.

3. Floor boxes and poke through devices shall be provided by the electrical subcontractor.

4. Device boxes with plaster rings for data shall be provided and installed by the electrical subcontractor.

5. Clock system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications subcontractor.

6. Telephone system, installation and cross connections and devices provided by Owner contractor.

7. Speaker/paging system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications subcontractor.

8. Structural blocking to support wall and ceiling mounted equipment shall be provided by the General Contractor.

9. Computers and monitors and final connections to wall outlets shall be provided by the Owner.

10. Interface with public utilities telephone service shall be arranged and provided by the Owner.

11. Wide Area Network connections shall be arranged and provided by the Owner.

12. CATV service and connections to installed systems shall be arranged and provided by the Owner.

13. Cabling and cable installation in Sections 274000 and 277000.

F. The installation, operating cost and maintenance of the controlled environmental conditions, for equipment located on site by the manufacturer, NFPA 70B, or as specified in these specifications shall be the responsibility of the General Contractor.

1.4 SYSTEM DESCRIPTION

A. General: This system shall provide a cabling infrastructure system for voice and high speed data. Furnish and install complete systems consisting of patch / cross connection panels, single mode fiber-optic cabling, multimode fiber-optic cabling, multimode cabling to the digital signs, main distribution frame (MDF) racks (2 post relay rack type AND 4 post type, intermediate distribution frame (IDF) racks (non-server type, 2 post), rack mounted power distribution units, TV suite racks (if/as shown on drawings, 4 post). Provide and terminate fiber and cabling as per the network riser detail drawing (T2.6) in all locations noted therein or as designated or inferred on the drawings. Provide appropriate amount of fiber termination ports in all areas to terminate all fiber. Provide all equipment as noted on the drawings or otherwise for a complete and functioning system. Ensure all fiber counts are correct independent of the quantities shown on T2.6. Where discrepencies occur, provide the higher cable count. Higher fiber counts may be submitted if it is economical to do so, however all fiber shall be terminated unless noted otherwise. The horizontal 4 pair Category 6A copper cabling system shall be guaranteed to exceed all TIA-568-B.2-10 link and channel performance requirements and be capable of supporting 10G Base-T (802.3an) and ISO/IEC 11801 applications for a total distance of 100 meters with equipment cords. The system shall be guaranteed to meet all Cat6A requirements

B. This specification describes the desired form, function and performance of the backbone and horizontal cabling system. It is the responsibility of the installer of this section to design and provide a fully functional system in accordance with the intent and stated performance of this specification or better. Provide all communications wire, cable, fiber-optic cable, devices and related facilities installed complete as shown or as implied on the Contract Documents for fully functional systems, including, but not limited to:

1. Data, Voice, Fax, Wap and CCTV horizontal cabling and Fiber Backbone Cabling System, grounding and equipment including but not limited to:

    a. Fiber Optic Backbone Cabling
    b. Fiber Optic Cabling for Video
    c. Fiber Optic Connectors
    d. Fiber Optic Patch Panels
    e. Equipment Racks and PDUs
    f. Vertical Cable Managers
    g. Cabling Distribution Support
    h. Category 6A Data cabling (BLUE)
    i. Category 6A WAP (OWAP, WAP4) cabling (GREEN)
    j. Category 6A CCTV cabling (YELLOW)
    k. Category 6A Voice cabling (WHITE)
    l. Category 6A Fax line cabling (GRAY)
    m. Category 6A for any other requirements (GRAY)
    n. Category 6A RJ-45 Style Jacks (colored to correspond to the color of cabling)
    p. Category 6A angled Patch Panels
    q. Category 6A Patch Cables as specified below.
    r. Cat6 cabling for fax lines (all fax lines homerun to MDF)

s. Electrical subcontractor shall provide cable tray sized 6”H x 20”W min.
t. Cabling Distribution Support (J hooks where no cable tray provided)
u. Stainless Steel Wall Phone face plates with recessed jacks
v. 110 blocks mounted on plywood backboard and cross over cabling for fax lines.
w. Grounding and bonding
x. Ensure all cabling is protected from paint and paint overspray. Any cabling found with paint on the jacket shall be removed and replaced at no expense to the owner.
y. Horizontal 2RU cable manager below each patch panel stack
z. All cabling shall be terminated in the IDFs or MDF as shown on the zone coverage drawings. Any deviations shall be brought to the attention of the architect.
aa. Provide and install two 2 inch conduit feed throughs from all sound closets to the accessible space above them for speaker and other cabling for the sound systems. Coordinate with 274000 communications subcontractor.

C. Work Not Included: The following work is not included in this section:

1. All computer workstations / printers and associated software (Provided by Owner)

2. Telephone system and instruments (Provided by Owner)

3. Public Address / Intercom System (Provided by 27 50 00)

4. Master clock system and secondary clocks (Provided by 27 50 00)

5. Video distribution system, TVs (Provided by 27 70 00)

6. Network electronics (Provided by Owner)

7. Wireless access point devices and controllers (Provided by 272133).

D. Coordination: Coordinate device locations with furnishings and equipment.

1.5 REFERENCE SPECIFICATIONS, STANDARDS AND CODES

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. Work shall meet or exceed the standards and procedures of the following:

1. ANSI/TIA/EIA 568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.

2. ANSI/TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components

3. ANSI/TIA/EIA 568.2 Addendum 1, Transmission Performance Specification for 4-Pair 100 Ohm Category 6 cabling

4. ANSI/TIA/EIA 568.2 Addendum 10, Transmission Performance Specification for 4-Pair 100 Ohm Augmented Category 6 cabling

5. ANSI/TIA/EIA 568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard

6. ANSI/TIA/EIA 569-B Commercial Building Standards For Telecommunications Pathways And Spaces

7. TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises

8. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard

9. TIA-568-C.2 Balanced Twisted Pair Cabling Components

10. TIA-568-C.3 Optical Fiber Cabling Components Standard

11. ANSI/TIA/EIA 606-A The Administration Standard For The Telecommunications Infrastructure Of Commercial Building

12. ANSI/J-STD-607-A Commercial Building Grounding And Bonding Requirements For Telecommunications

13. ANSI/TIA/EIA-862 Building Automation Systems Cabling Standard for Commercial Buildings

14. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers

15. ASTM D 4566-05, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable, 2005

16. BICSI Telecommunications Distribution Methods Manual (TDMM) Current Edition

17. BICSI Information Transport Installation Manual (ITSM) Current Edition

18. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premise

19. IEEE 802.3 Standard for Information technology -Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

20. IEC 61156-1, Multicore and Symmetrical Pair/Quad Cables for Digital Communications – Part 1: Generic Specification, 2005

21. NFPA-70 National Electrical Code 2008 edition

22. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling

23. Federal Communications Commission Part 15 and Part 68

24. UL 444 – Standard for Safety of Communications Cable

25. UL 1666 – Standard for Safety of Flame Propagation Height

26. NFPA 262 – Flame Travel and Smoke of Wires and Cables.

27. BICSI Outside Plant Design Reference Manual, Current Edition

In the event of conflicts, the more stringent provisions shall apply.

1.6 COORDINATION

A. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Communications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Communications System Integrator and Architect. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Communications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

E. Where a PB symbol is present, provide a minimum of 1 blank port in the A faceplate at the PB location for PB wiring.

F. Coordinate with HVAC contractor the exact placement of ALL AC units, condensate and drain lines, to ensure NO AC unit is installed above ANY rack or plywood backboard in the MDF and all IDFs. No drain lines shall be routed above an equipment rack.

G. Coordinate elevator camera installation and card reader cabling with elevator contractor. Communications subcontractor of this section is responsible for all cabling and terminations of elevator CCTV camera installation except for traveller cabling. Elevator contractor is responsible for traveller cabling and connections to traveller cabling. Coordinate cabling requirements of elevator camera with 28 00 00 communications subcontractor. Equipment required for camera installation and connections to cabling (other than traveller cable) is the responsibility of the 28 00 00 communications subcontractor.

1.7 SUBMITTALS

A. General: Architect may require submittal submission within 45 days of bid award. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, Section 01300 and Section 26 00 00. Submittals shall be made as one complete package.

B. The Submittal shall include, but shall not be limited to the following:

1. Product Data for each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned plan and elevation views of components. Provide an index and tabulated pages referencing the equipment in the specification. Any submittal received without a full index and tabulated pages shall be returned without action.

2. Provide qualification/certification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Provide evidence of applicable registration or certification.

3. Field test and observation reports from qualified inspecting and testing personnel indicating and interpreting test results relative to compliance with performance requirements of the installed systems.

4. Final schedule of cables as specified in Part 3.

5. Shop drawings, prepared in AutoCAD, readable in AutoCAD Release 2010 or newer, detailing the cabling systems.

C. Shop drawing submittals shall include but shall not be limited to the following:

1. Construction plans indicating the following:

   a. Locations of all voice, data & audio/visual backbone cables with identification numbers.

   b. Location of termination racks and backboards.

2. System riser diagram indicating general arrangement of interconnections between system components on each floor of the building, identifying number and type of cables in each raceway.

3. Horizontal cabling, fiber, concentrator enclosures, MDF/IDF racks, and cross connect system. Include front-view details identifying all components, cabling connections, and cable identification numbers.

D. Cable Schedules: Prior to substantial completion, prepare and submit cable schedules for each of the communication systems installed under this section describing the as-built condition of the systems. Prepare cabling schedules in tabular form. Include the following information in each schedule:

1. Fiber Optic and Horizontal Cabling System Schedule:

   a. IDF/MDF room number
   b. Cable ID
   c. Origination Patch Panel & Port Number.
   d. Destination Room (old and new numbers if they change during construction)
   e. Destination Room faceplate location and jack number.

E. It is intended for the Submittal data to be complete and accurate at the first submission. If the submittal is returned marked "Resubmit" only one additional submission will be permitted. IF THE SECOND SUBMITTAL IS NOT ACCEPTABLE, OR IF THE SUBMITTAL IS NOT MADE WITHIN THE SPECIFIED TIME FRAME, THE RIGHT OF SUBSTITUTION AND

SELECTION WILL BE LOST. THE OWNER WILL SELECT THE SPECIFIED ITEM. THAT ITEM IS TO BE PROVIDED AND SHALL BE PROVIDED AT NO ADDITIONAL COST.

F. A minimum period of 15 working days, exclusive of transmittal time, will be required in the Owner's office each time Shop Drawings, Product Data, layout drawings, catalog data and brochures are submitted or resubmitted for review. A minimum period of 20 working days exclusive of transmittal time will be required for reviewing substitute materials or manufacturer. These time periods shall be considered when scheduling the work.

G. If proposed equipment deviates from the Specification or Drawings, indicate in writing on Company letterhead those differences and provide sufficient data to justify acceptance. FAILURE TO INDICATE DEVIATION OR SUBSTITUTIONS IMPLIES FULL COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

1.8 RECORD DRAWINGS

Provide Record Drawings in accordance with Division 1 for requirements regarding Project Record Documents.

"As- Built" record documentation for telecommunications work shall include:

System function diagrams.
Communications flow diagrams.
Manufacturers' description literature for equipment.
Connection and programming schedules as appropriate.
Equipment material list including quantities.
Spare parts list with quantities.
Details not on original Contract Documents.
Test Results
Warranties
Release of Liens

Operation and Maintenance Manual:

Refer to Section 01 33 00 - Submittals for requirements pertaining to Operation and Maintenance Data.

The Communication System Integrator shall submit manuals in accordance with Division 1 containing manufacturers' brochures of items installed by the Communication System Integrator.

The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

Operations manuals for components and for system as a whole.

Maintenance manuals for components and for system as a whole.

Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.

List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.

Emergency instructions for operational and maintenance requirements.

Delivery time frame for replacement of component parts from suppliers.

Recommend inspection schedule and procedures for components and for system as a whole.

Complete “Reviewed” shop drawings and product data for components and system as a whole.

Troubleshooting procedures for each system and for each major system component.

Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD. Each faceplate shall show the faceplate port number and terminating servicing closet room number with patch panel letter and port number.
2. Maintenance Data: Include three (3) copies: maintenance and repair procedures.
3. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.
4. Warranty paperwork certified and provided by both the installer (installer/subcontractor warranty min 15 years) and the cable manufacturer warranty (min 15 years). Warranty certificates shall include contact numbers.
5. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse, etc).
6. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.9 QUALITY ASSURANCE

Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect.

A. Installer Qualifications: Installer shall engage a registered communications distribution designer (RCDD) as part of the communications subcontractor team. Such RCDD can be an employee or consultant, but must be certified by the Building Industry Consulting Service International (BICSI). RCDD shall perform post bid review of the cable plant and bring any discrepencies to the attention of the architect. RCDD shall provide to Owner and Architect rack elevations for all racks in MDF and IDFs when actual cable plant is determined, to include UPS devices, patch panels (cat6A and fiber), CCTV system and NVRs, access control servers, phone equipment, intrusion system equipment, switching and wireless equipment and owner equipment. Coordinate equipment with contractors of the appropriate sections and owner. RCDD shall ensure no cable lengths are over distance limitations set forth in the standards, and shall bring any discrepancies to the attention of the architect.

Coordinate actual rack placements in MDF and IDFs with architect and owner. RCDD shall review outdoor fiber plant design and bring any discrepancies to the attention of the architects. RCDD Is intended for post bid review and coordination.

B. Manufacturer Qualifications: Manufacturers shall be experienced in manufacturing components listed and labeled under TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3.

C. Comply with the following:

1. TIA-568C.0, Generic Telecommunications Cabling for Customer Premises
2. TIA-568C.1, Commercial Building Telecommunications Cabling Standard
3. TIA-568C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
4. TIA-568C.3, Optical Fiber Cabling Components Standard
5. ANSI/TIA/EIA-526-7 Measurement of Optical Power Lossof Installed Single-Mode Fiber Cable Plant.
6. ANSI/TIA/EIA-14A Measurement of Optical Power Lossof Installed Multimode Fiber Cable Plant.
7. ANSI/TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.
8. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
9. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.
10. BISCI Telecommunications Distribution Methods Manual Standards, most recent volume.

D. All wiring must be run end to end with no splices (except for fiber, where splices are specified to be provided in certain locations). Terminated cables shall be punched down meeting approved methods. Any cables found to be spliced must be replaced at communications subcontractor's expense.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

F. Work Coordination: Coordinate Work of this Section with owner's contractor for the telephone switch and telephone instruments, planned equipment, 27 40 00 communications subcontractor, wide area network (WAN) installed by Owner, 28 00 00 communications subcontractor for CCTV placements and the Technology Director of the School District.

1. Record agreements reached in meetings and distribute record to all participants in the meetings.

2. Adjust the arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize the arrangement and space requirements of the telephone switch, LAN equipment, CATV Equipment and WAN equipment.

G. Communications subcontractor must be certified by the cabling manufacturer to install, terminate and warrant cabling systems. Provide proof of manufacturers' certification for systems to be installed.

1.10 SUPPORT MATERIALS

A. Furnish support materials described below that match products installed, are packaged for storage, and are identified with labels clearly describing contents.

1. Cable: One 100ft spool of each size and type used for Project. Furnish on reels.

2. Patch Panel Units: 1 of each type for each 50 installed, but not less than 1.

3. Connecting Blocks: 1 of each type of each 100 installed, but not less than 1.

4. Outlets Assemblies: 1 of each type for each 100 installed, but not less than 1.

1.11 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the communications subcontractor under other requirements of the Contract Documents.

B. Special Warranty: The data cabling system, including workstation outlets, cabling, connectors, patch panels and other connecting hardware, shall be warranted to be free from defects in material or faulty workmanship, and shall meet the performance requirements of TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3. The cabling system shall conform to the ANSI/TIAIEIA-568-B, specifications for any current or future application, which supports transmission over a properly constructed horizontal cabling system, which meets the channel, and/or basic link performance as described in TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3

C. The warranty shall cover material, services, and operation of the cabling system, end to end to include connectors/terminations, both copper and fiber. The warranty shall cover the operation of system to run minimum 1GB transmission on horizontal cabling category 6 systems, 10GB transmission on horizontal cabling category 6A systems, and 10GB on Multi-Mode Fiber backbone without exceeding the standard attenuation limit.

1. Special Warranty Period: 15 Year MINIMUM from date of acceptance. Provide warranty from Installer and manufacturer. Installer shall submit warranty tests to manufacturer on behalf of the owner and deliver the manufacturer warranty to the owner when complete.

D. The manufacturers of connectivity and cabling will certify installing communications subcontractor on the project to be warranted.

E. The communications subcontractor must be certified with the connectivity and structured cabling to be installed in the project that the communications subcontractor will be installing.

F. The communications subcontractor will supply a letter or other document that will detail the

certification in regards to the connectivity and cabling systems installed to the Technology Services Department and/or Construction Manager prior to the final inspection and close of the project.

G. All test results and warrantees for connectivity and structured cabling shall be submitted to the Technology Director (Minimum two (2) copies of test results will be required in electronic format). Submittals must be received prior to substantial completion. Communications subcontractor is responsible for obtaining warranties for cabling. Provide ALL warranties the cabling system qualifies for.

H. Uncertified communications subcontractors will be required to remove structured cabling and pay for replacement by another certified communications subcontractor if the installation is not in compliance with certifying manufacturer or contract standards at no additional expense to the Owner.

J. Certifying manufacturers may be required to do inspections of cabling systems on project.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be suitably packaged by manufacturers to prevent damage during shipment and handling. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area.

PART 2 - PRODUCTS

MATERIALS:

Manufactured Products:

Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.

Equipment Assemblies and Components:

Components of an assembled unit need not be products of the same manufacturer, but must meet TIA/EIA Category 6A or 6, depending on cable type, criteria as a complete permanent link.

Manufacturers of equipment assemblies shall assume complete responsibility for the final assembled unit.

Components shall be compatible with each other and with the total assembly for the intended service.

Moving parts or elements of equipment of the unit normally requiring lubrication shall have means provided for such lubrication and shall be adequately lubricated at the factory prior to delivery.

Factory cabling shall be identified on the equipment being furnished and on cabling diagrams.

Any equipment listed by manufacturer and/or model number is for performance criteria comparison only. In no way is it implied that the specific product must be provided. All equipment to be provided shall be 'or equal' unless noted as proprietary in the specification.

2.1 NETWORK BACKBONE CABLING

A. General:

1. The following types of backbone cables shall be used on this project:

    a. Single-Mode (SM) 9/125um fiber and OM4 Multimode 50/125um fiber cable for 10GB backbone distribution of data, voice, video, CCTV and video transmission backbone.

2. All Single-Mode and Multimode fiber for the backbone shall be terminated with LC style connectors.
3. See T2.6 and other technology drawing details for fiber types and strand counts
4. All fiber shall be run in appropriately sized innerduct. Riser-Gard by Carlon or equal by Maxcell or Pyramid for indoor fiber; Maxcell innerduct, with cells and size to fit applications for outdoor fiber or equal by Carlon or Pyramid. Armored fiber may be used in lieu of fiber and innerduct.
5. Determine splicing locations, provide and install splices and equipment and all requirements to provide designed intent on T2.6 network riser detail an dtechnology drawings. It is the responsibility of the communications subcontractor of this section to ensure a fully functional fiber plant (both single mode and multimode). Provide a loss budget analysis to make certain the system will function appropriately in accordance with standards over the proposed link. See owner for network electronics. RCDD shall approve loss budget analysis prior to work being performed. Forward copy of loss budget analysis to the architect.

B. OS2 Single-Mode Fiber-Optic Cable- SM 9/125um:

1. The fiber-optic cable shall be tightbuffer indoor/outdoor factory-fabricated, jacketed, low-loss, glass-type, fiber-optic single-mode, operating at 1310 nanometers (nm) and 1550nm.

    a. Strands Per Cable: as per drawing details. See T2.6 and T2.1
    b. The light guide building cable shall meet the following technical specifications:

        1. Fiber Dimensions: 9 micron core 250 micron coating 125 micron cladding 900 micron buffering
        2. Fiber Identification: Individually color-coded PVC buffer.
        3. Buffer Material: PVC
        4. Jacket Material: PVC
        5. Operating Temperature: -40 to 158. F

2. In cables with more than one fiber, the fibers shall be stranded around a dielectric central member.

3. The cable and sub-unit jacket color shall be yellow for cables containing single-mode fibers, orange for multimode fibers. (Colored tape will not be used to re-identify jacket color).

4. The cable shall be all dielectric.

5. The individual fibers shall be color coded for identification. The optical fiber color-coding shall be in accordance with ANSI/TIA/EIA-598-A, “Optical Fiber Cable Color Coding.” The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another. The following color codes will be used:

    a. Blue.
    b. Orange.
    c. Green.
    d. Brown.
    e. Slate.
    f. White.
    g. Red
    h. Black.
    i. Yellow.
    j. Violet
    k. Rose
    l. Aqua

6. Jacket Printing: The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The print color shall be black. The printing shall be permanent and legible for the life of the cable.

7. The fiber-optic cable shall meet the following standards:

    a. ISO 11801 2nd edition
    b. EN 50 173 2nd edition
    c. TIA-568C.3
    d. ANSI/TIA/EIA-492
    e. TELECORDIA GR-409
    f. ICEA S-83-596
    f. OFNR rated.
    g. NEC Section 770.

8. The optical fiber shall be single mode 9/125-micron fiber with the following characteristics:

    a. 1310nm: maximum attenuation, .80 dB/km
    b. 1550nm: maximum attenuation, .50 dB/km
    c. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB in any one-kilometer length of fiber.

9. The cable shall meet the following EIA cable tests:

a. Impact EIA-RS-455, FOTP-25
b. Compression EIA-RS-455, FOTP-41
c. Flexure EIA-RS-455, FOTP-104
d. Tensile Bending EIA-RS-455, FOTP-33
e. Temperature Bending EIA-RS-455, FOTP-37
f. Twist Testing EIA-RS-455, FOTP-85
g. Flame Test (OFNR) UL 1666 (NEC)

10. Packing and Shipping:

    a. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The cable packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
    b. Wooden reels shall be plainly marked to indicate the direction in which it would be rolled to prevent loosening of the cable on the reel.

11. The cable shall be Mohawk OS2 SM grade cable, of type appropriate for design intent or equal by Superior Essex or Corning. Outdoor grade cable required for any exterior fiber installations.

C. OM4 Fiber-Optic cable MM 50/125um. Strands as per T2.6 and other technology drawing details.

1. The fiber-optic cable shall be factory-fabricated, jacketed, low-loss, glass-type, fiber-optic multi-mode, graded index, operating at 850 nanometers (nm), and 1300 nm.

    a. Strands Per Cable: as shown on riser drawing T2.6.
    b. The light guide building cable shall meet the following technical specifications:

        1) Fiber Dimensions: 50 micron core 250 micron coating 125 micron cladding 900 micron buffering
        2) Fiber Identification: Individually color-coded PVC buffer.
        3) Buffer Material: PVC
        4) Jacket Material: PVC
        5) Operating Temperature: -40 to 158. F
        6) Storage Temperature: -40 to 158. F

2. In cables with more than one fiber, the fibers shall be stranded around a dielectric central member.

3. The cable and sub-unit jacket color shall be orange for cables containing multi-mode fibers. (Colored tape will not be used to re-identify jacket color).

4. The cable shall be all dielectric.

5. The individual fibers shall be color coded for identification. The optical fiber color-coding shall be in accordance with ANSI/TIA/EIA-598-A, “Optical Fiber Cable Color Coding.” The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another. The following color codes will be used:

    a. Blue. .

b. Orange.
c. Green.
d. Brown.
e. Slate.
f. White.
g. Red
h. Black.
i. Yellow.
j. Violet
k. Rose
l. Aqua

6. Jacket Printing: The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g., "COMPANY — 01/94 — 50/125 MICRON — Type OFNR-(UL) 00001 FEET"). The print color shall be black. The printing shall be permanent and legible for the life of the cable.

7. The fiber-optic cable shall meet the following standards:

   a. ANSI-FDDI.
   b. ANSI/TIA/EIA-568-C.3-1 for 550 meter lenghts @ 10gb data rates.
   c. ANSI/TIA/EIA-526-14.
   d. ICEA S-83-S96.
   e. TR-NWT-000409.
   f. UL 1666.
   g. OFNR rated.
   h. NEC Section 770.
   i. ISO 11801

8. The optical fiber shall be multi mode 50/125-micron fiber with the following characteristics:

   a. 850nm: maximum attenuation, tight buffered, 3.5 dB/km Minimum Modal bandwidth, 500 Mhz.km. Loose tube max attenuation 3.0 dB/km.
   b. 1300nm:maximum attenuation, tight buffered, 1.25 dB/km Minimum Modal bandwidth, 500 MHz.km. Loose tube max attenuation 1.0 dB/km.
   c. The attenuation specification shall be a maximum attenuation for each fiber
   d. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB in any one-kilometer length of fiber.

9. The building cable shall meet the following EIA cable tests:

   a. Impact EIA-RS-455, FOTP-25
   b. Compression EIA-RS-455, FOTP-41
   c. Flexure EIA-RS-455, FOTP-104
   d. Tensile Bending EIA-RS-455, FOTP-33
   e. Temperature Bending EIA-RS-455, FOTP-37
   f. Twist Testing EIA-RS-455, FOTP-85
   g. Flame Test (OFNR) UL 1666 (NEC)

10. Packing and Shipping:

    a. The cable shall be packaged in cartons and/or wound on spools or reels. Each

package shall contain only one continuous length of cable. The cable packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

b. Wooden reels shall be plainly marked to indicate the direction in which it would be rolled to prevent loosening of the cable on the reel.

11. The cable shall be Mohawk grade 6 OM4 indoor riser distribution cable or equal by Superior Essex or Corning and Mohawk grade 6 OM4 outdoor grade loose tube or equal by Superior Essex or Corning, for all exterior applications.

D. Fiber Termination Hardware:

1. Provide/install/terminate all fiber provided as shown on the network riser drawings. All fiber shall be terminated with LC style terminations; different colors shall be used for SM and MM. The MM fiber to the digital sign shall be terminated at the sign with LC style connections, final connection shall be provided by the subcontractor responsible for the digital sign. Each fiber termination shelf shall include appropriate cable slack storage, labeling and strain relief.

2. Fiber termination shelves shall be mounted at the top of the rack containing the electronic equipment.

3. Cable Connectors: LC-style connectors shall be used on ALL fiber. Polish: Flat PC; Termination procedure: pigtail splice (SM) or epoxy/polish (SM/MM). Insertion loss of connectors shall not be greater than .7dB

4. SM Fiber from V8 faceplates shall be terminated in TV Head End room at top of rack by wall.

5. Provide/install/test splices to provide design intent.

2.2 FIBER PATCH PANELS

A. Fiber Optic Patch Panel and Rack Mount Enclosure

1. Patch panels shall have an anodized aluminum finish.

2. Patch panel shall have a clear cover on rear.

3. Patch panels shall be 6-Pack quad LC (24 fiber) type plates (as appropriate for the type of fiber being terminated) to terminate every strand of fiber in an enclosure no larger than 4U

4. Rack enclosure shall mount in a 19” equipment rack.

5. Rack enclosure shall have a front door with cable management and be constructed of durable polycarbonate plastic and black powder coated 16-gauge steel. Leviton Opt-X Ultra or equal by Corning or Hubbell.

2.3 NETWORK HORIZONTAL CABLING

A. General:

1. The following types of data/signal cables shall be used on this project:

   a. 4 pair Category 6A cable for distribution of Data signals. (Blue)
   b. 4-pair Category 6A cable for distribution of Wireless Access Point signals. (Green)
   c. 4-pair Category 6A cable for distribution of CCTV signals (Yellow)
   d. 4-pair Category 6A cable for distribution of Voice signals (White)
   e. 4-pair Category 6A cable for Fax lines (Gray)
   f. 4-pair Category 6A cable for any other faceplate (Gray).

2. TERMINATION HARDWARE: The following types of connectors shall be used on this project:

   a. Category 6A Jacks, BLUE, GREEN, WHITE, BLACK, YELLOW, RED, PURPLE.

B. Augmented Category 6 Cable DATA, VOICE, CCTV, WAP, and other faceplates as shown on drawings.

1. The Category 6A cable shall use the color code indicated below:

   c. All Category 6A cable for Data, projectors and set top boxes shall be Blue.
   d. All Category 6A cable for Voice shall be White
   e. All category 6A cable for Fax lines shall be Gray.
   f. All Category 6A cable for CCTV shall be Yellow.
   g. All Category 6A cable for WAPs shall be Green.
   h. Any other Category 6A required shall be Gray.
   i. Colored tape may not be used to re-identify jacket color.

2. The cable shall be composed of 23-gauge bare solid copper conductors. Cable shall be insulated with a marked (every 2 ft) polyethylene vinyl chloride jacket. There shall be no shield required in the sheath.

3. Each sheath shall contain 4 unshielded copper twisted pairs. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

4. The cable shall be sweep tested to 750MHz and operate up to 500MHz.

5. The cables shall meet or exceed the following standards:

   a. IEEE 802.3an
   b. ICEA 580-576.
   c. Canadian Standards Association IWC FT4.
   d. National Electric Code - Article 800.
   e. Proposed ANSI X3T9.S requirements for UTP at 100 Mbps and 155 Mbs ATM.
   f. Cable manufacturer must be ISO-9002 Certified.
   g. TIA-568-C.2 CAT 6A
   h. ISO/IEC 11801E2.1 CAT 6A
   i. IEC 61156-5 CAT 6A Horizontal cable

6. In addition to complying with the above listed standards, all Augmented Category 6 cables shall meet or exceed the following criteria:

    a. Testing shall be in accordance with procedures in the referenced standards unless otherwise stated.

    b. All cables shall meet, as a minimum, the requirements of:

        1. CSA
        2. NEC
        3. UL444
        4. TIA-568-C.2 Category 6A
        5. ISO/IEC 11801 Category 6

    c. Factory splices of the insulated wire are not allowed in any portion of the cable, Butt-welded conductors prior to insulating are permitted.
    d. Nominal OD: .295”
    e. Conductor DCR: 6.6 ohm/100m MAX
    f. DCR Unbalanced: 3% MAX
    g. Mutual capacitance:46pF/m NOM
    h. Capacitance unbalance pair/ground: 33pF/100m MAX
    i. Characteristic impedance: 100 ohm +/- 7% (10-550MHz)
    j. Prop delay: 534 +36/ fns/100m MAX
    k. Prop delay skew: 45 ns/100m MAX
    l. Nominal velocity of propagation: 68% non plenum, 72% plenum (f=frequency in MHz from 1-500)

The cable shall be GigaLan 10 Augmented Cat 6 by Mohawk or equal by Berk-Tek or Belden. Label cables as per direction for patch panel paragraph below.

2.4 TERMINATION HARDWARE

A. Modular 8 position modules:

1. Termination hardware shall be designed with an integral locking mechanism, which upon insertion of a modular plug provides maximum pullout strength at the plug/jack interface.

2. All modular 8-position jacks shall be RJ-45, T 568B wired.

3. The jacks shall meet or exceed the following standards:

    a. TIA/EIA-568-B.2-10 Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling and the TIA-568C.2 Balanced Twisted Pair Cabling Standards

4. The modular jacks shall meet the following electrical performance and certification requirements:

    a. The modular jacks shall meet TIA/EIA-568-B.2-10 Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling and the TIA-568C.2 Balanced Twisted Pair Cabling Standards

    b. Near End Crosstalk (NEXT) and Attenuation measurements shall be made per applicable TIA-568B.2 standards for Cat 6A.

5. The modular jacks shall meet the following requirements:

   a. Connector-insulation displacement connectors shall be capable of accepting 23 gauge AWG solid conductor wire.
   b. Terminated in accordance with EIA-568B specifications.
   c. Data/Wap/Voice/Fax jacks shall be RJ45.

6. The jack shall be approved to work in all applications up to 10 Gb/sec, including, but not limited to 1Gb/sec and 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), proposed 155 Mb/sec ATM, 16 Mb/sec token ring, 10 Base T and 4Mb/sec token ring.

7. The modular jacks shall use the color code indicated below:

   a. Data - Blue
   b. WAP - Green
   c. Voice – White
   d. Fax – Red
   e. CCTV – Yellow
   f. Set top boxes – Black (first data port on all T1 locations)
   g. Bottom data port at VA plate: Purple. Top jack Blue.
   h. Data at TV location, both jacks BLACK for Set Top Box.
   i. Projector data in Auditorium booth purple, top left jack in D4 behind rack black for set top box.
   j. Library Media Seminar room projector jacks: One jack Purple one Blue. Top left jack in D4 at rack: black.

   Category 6A jacks Leviton 6110g-RL6 or equal.

B. CCTV cable requirements

1. Install a single gang back box at CCTV locations (for exterior camera locations, mount box inside where conduit goes outside for exterior CCTV locations) with single port faceplate and Cat6a RJ45 yellow keystone jack. Secure box to the nearest building structure. Cat6A jack shall be yellow. Provide a 2' service loop of Cat6A at the single gang box. All single gang boxes shall be hidden from view. All CCTV cabling shall be included in the Cat 6A cable tests.

2.5 PATCH PANELS

A. Category 6A- Data (including projector and set top box cabling), Wap, Voice and CCTV

1. All patch panels shall be Cat 6A angled 110 style patch panels, 24 or 48 port T568B wired, 2U maximum and all patch cords shall be routed directly into the vertical cable mangers. 6A587-U24 or 6A587-U48 by Leviton or equal. Provide each type of cable on it’s own patch panel in each rack:
   a. Data
   b. Voice
   c. CCTV
   d. WAP
   e Set top box and Projectors

2. Provide straight cat6a patch panel and horizontal 2RU cable management panel below patch panel in rack in TV head end room 4 post rack, for local TV suite data network cabling as noted on drawings.
3. Patch panel ports connected to Black jacks shall be labeled S and have a color designation of black and shall have black patch cords provided. Projector data ports (all purple jacks), shall have the patch panel ports labeled P and have a purple color designation. Purple patch cords shall be provided for these ports.
4. Other ports shall be color labeled according to their cable color (green for wap, yellow for CCTV, white for voice, blue for data).

2.6 110 BLOCKS AND CROSS OVER CABLING

A. Provide and install on plywood backboard in MDF two (2) 110 wiring block with legs for fax line cross over cabling. Leviton 41aw2-100 with legs or equal by Hubbell or Siemen.

B. Terminate fax lines to 110 Blocks on plywood backboard. Cross connect phone line service provider's DEMARC for fax lines to 110 block and verify ALL fax lines as designated on the drawings function by testing fax capability of each phone line.

C. Fax lines shall be terminated with a single gang single port faceplate with black RJ45 keystone jack at the fax machine location.

2.7 CAT 5e MULTIPAIR CABLE

A. Provide plenum multi-pair Cat 5e cable from the MDF to each IDF as shown on the T2.6 drawing. Terminate both ends on 66 blocks with Amphenol connectors on the sides of the 66 blocks on plywood backboard in IDF and MDF.

Cable is by Mohawk in quantities required for cable counts shown on T2.6 or equal by Belden or Berk-Tek.

2.8 EQUIPMENT RACKS

A. Provide: All 2 post racks in MDF (provide and install), IDF racks (provide and install as shown on the drawings); shall be 7' tall, aluminum or steel floor-mounted and have mounting rails for standard 19" equipment. Provide racks as per technology drawing details. Provide and install at all two post racks (MDF, IDF, and other areas where a two post rack is shown on the drawings or as specified) uni-strut, threaded rod and other hardware required to secure the rack to the wall or building structure. Rack deflection shall not be more than 1" at top of rack.

B. All 2 post racks shall meet the ANSI/EIA 310-D standard and include the universal 5/8" hole pattern drilled on the front and rear.

C. All racks shall be properly grounded and bonded in accordance with ANSI/TIA/EIA-607, A minimum 6 AWG green conductors shall be used for grounding.

D. Provide vertical racks with horizontal (ladder type) cable trays (20" minimum) connecting all racks. A horizontal cable tray shall connect the telecommunications on the ¾" thick AC-grade or better fire-retardant plywood with at least two coats of flame retardant paint with the vertical racks. All cable tray/ladder rack shall be no more than 10" away from top of racks.

E. Double-sided vertical cable management sections shall be provided for each 2 post rack. Vertical management sections may be integrated into the rack design or attached separately. Vertical management sections shall be provided for both sides of each individual rack. If more than one rack is installed in a row, a single vertical management section may be used to adjoin two racks. Eight (8) inch wide double-sided vertical cable management sections shall

be provided for each side of each 2 post rack (Leviton 8980L-VFR or equal).

F. Provide two power distribution units (PDUs) (208v, 30amp) in each rack provided in this section. Each power strip shall be provided with a min 10' power cord to be neatly run from the power strip, at its furthest mounting location, through the equipment racks to the electrical outlets mounted on the bottom of the cable tray. Provide extension cords to twist lock plugs if required. 208v power cord shall have a twist lock type NEMA L6-30P plug. Provide two of each PDUs listed below at every rack (to include PA and IPTV, 2 posts and 4 posts) in the MDF and IDFs. PDU: AP7911A. Provide and install gray patch cord to local switch (switch provided by owner).

G. 4 post racks: provide four (4) 4 post racks in the MDF (as shown on the drawings, includes CCTV rack and IPTV). Middle Atlantic MRK 4431LRD. Provide a set of sides for each rack in the MDF (4 total pair of sides, part number SPN-44-312)). 275000 subcontractor shall supply cabinet for PA system.

1. All 4 post racks shall be 83.125" tall, 31.40" deep steel floor-mounted and have 10-32 threaded mounting rails, front and back, for standard 19" equipment. Provide racks as per technology drawing details. Secure racks to floor.

2. All racks shall be properly grounded and bonded in accordance with ANSI/TIA/EIA-607. A minimum 6 AWG green conductor shall be used for grounding.

2.9 CABLE TRAY ACCESSORIES

A. Electrical subcontractor (26 00 00) to provide and install one (1) 120V 30 amp twist lock outlet NEMA type L5-30 to the bottom of the cable tray above each rack on drawings for the IDFs and MDF. Electrical subcontractor shall provide electrical service and twist lock plugs as appropriate as shown on the drawings. Electrical subcontractor shall provide two 208V 30 amp L-6 twist lock plugs above every rack in the IDFs and MDF.

B. Electrical subcontractor (26 00 00) shall furnish and install "drop outs" where cabling drops out of cable tray above equipment racks and enters vertical wire management panels and at plywood backboards.

C. Electrical subcontractor (26 00 00) shall supply and install ladder rack from the equipment racks to the plywood backboard if cable tray is not shown on the drawings. Provide 20" wide ladder rack, by B-Line or equal with dropout section at plywood backboard. Ladder rack shall be within 10" above the racks.

2.10 Patch cords

A. Provide Cat-6A blue patch cords for every data port wired (except as identified below), Cat-6A green patch cords for every WAP port wired and Cat-6A yellow patch cords for every CCTV port wired and Cat-6A white patch cords for every voice port wired. Provide Cat-6A Black patch cords for every Black jack wired, and Purple Cat6A patch cords for the purple jacks wired. Provide these cables in lengths of 70% are 5', 20% are 7' and 10% are 10' of the terminations. Provide 10% extra of each length and color.

B. Provide 10' Gray Cat6 patch cord for VES port.

C. Provide patch cords for unused ports to owner.

D. Provide patch cords of appropriate length to connect floor data and voice ports to furniture data and voice ports as noted on the drawings. Cat6A, Blue for data, and Cat6A White for voice. Provide pass thur Cat6 jacks jacks and install in furniture. Connect jacks with patch cords to floor box jacks below.

PART 3 - EXECUTION

3.1 DISTRIBUTION OF CABLING WITHIN THE SCHOOL

A. Main Distribution Facility: The Main Distribution Facility (MDF) is a dedicated and secured room within the school that will host a major portion of the network equipment. Equipment racks shall be provided in the MDF, which shall support:

1. Wide area network (WAN) access equipment.

2. A majority of the local area network (LAN) equipment including the router, switching, and uninterruptible power systems (UPS).

3. Termination of fiber cabling from IDF(s) and other areas.

4. Termination of data cabling from MDF service zone workstation jacks.

5. Termination of voice, wap and CCTV cabling from MDF service zone workstation jacks

6. MDF- shall have multiple systems:

   a. Category 6A Data - Rack Mounted
   b. Fiber Optics Data- Rack Mounted
   c. Category 6A horizontal voice cabling - Rack Mounted.
   d. Intrusion detection and access control system- rack and back board mounted
   e. Servers- Rack mounted
   f. IPTV video distribution system- Rack mounted
   g. Intra-building communications System Control Cabinet
   h. Telecommunications and CATV entrance facilities.
   i. CCTV system

B. Intermediate Distribution Frames: (IDF) are dedicated and secured rooms within the school that will host a satellite portion of the technology infrastructure equipment. 2 post equipment racks shall be provided as per the drawings in each IDF, which shall support:

1. Local area network (LAN) equipment including the switching, and uninterruptible power systems (UPS).

2. Termination of fiber cabling from MDF.

3. Termination of data cabling from IDF service zone workstation jacks.

4. Termination of voice cabling from IDF service zone workstation jacks.

5. Termination of CCTV cabling from IDF service zone.

6. Termination of IPTV cabling from IDF service zones.

7. Other system equipment if necessary

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

Protect materials and equipment from damage during storage at the site and throughout the

construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.

Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

3.3 WORK PERFORMANCE

Coordinate location of equipment and conduit with other trades to minimize interference.

Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the ARCHITECT and OWNER as require by limited working space.

Holes shall be located so as not to affect structural sections such as ribs or beams.

Holes shall be laid out in advance. The ARCHITECT and OWNER shall be advised prior to drilling through structural sections, for determination of proper layout.

Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

3.4 ACCESS TO EQUIPMENT

Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.

Working spaces shall be not less than specified in the National Electrical Code for voltages specified.

Where the ARCHITECT and OWNER determine that the Communications Subcontractor has

installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the ARCHITECT and OWNER, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.5 CABLE TERMINATIONS AND DRESS

Installation of signal, video, communication and control conductors shall adhere to the following:

Cables shall be dressed, labeled and tie wrapped in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the Communications Subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

Cables shall be secured to equipment cabinet backboards, console members or to other system components using cable clamps and wraps. The Communications Subcontractor shall furnish and install cable support posts to facilitate system installation.

Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

3.6 EXAMINATION

A. Examine pathway elements to receive cable. Check raceways, wire ways, cable trays and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Prior to the start of actual installation, the communications subcontractor shall review the exact location of all cables, outlets, and equipment with the Owner, Construction Manager and the suppliers of related equipment.

C. The communications subcontractor shall coordinate the equipment installation with the installation of raceways, to eliminate potential damage to cables.

3.7 INSTALLATION

A. Wiring Method: Install wiring with J-Hooks (except where cable tray is available). Comply with ANSI/TIA/EIA-569A for conduit sizing not indicated on Contract Drawings. Do not exceed the manufacturer’s minimum bend radius. Comply with requirements listed in STELL DECKING specification (see related work section of this specification). The horizontal system cables shall be run using a star topology format from the MDF and/or IDFs rooms to the technology outlets as shown on the technology drawings. The length of each individual CAT 6A cable run between patch panels in the MDF and IDFs to each technology outlet or termination shall not exceed 300-ft. Cables may be routed through rooms and other spaces in the event that cable routing through main hallways negatively affects the requirement that the length of each individual cable run not to exceed 300-ft (90m) (terminated end to terminated end). Cabling which deviates from the main pathways shall be identified on the floor plans by the

communications subcontractor.

B. Install components as indicated, according to manufacturers' written instructions. Use techniques practices, and methods that are consistent with the Category 6A rating of the components and that assure Category 6A performance of completed and linked signal paths, end-to-end.

C. Install cable without damaging conductors, shield, or jacket.

D. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturers. Maintain recommended manufacturer's minimum bend radii of all UTP and fiber optic cabling at all times.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously where more than one is being installed in the same raceway.

2. Use "thin film" pulling lubricants only. It has been shown that lubricants will affect testing as the cable needs several weeks to dry before attenuation levels recover.

3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.

F. Install exposed raceway parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

G. Secure and support cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

H. Wiring within Wiring Closets and Enclosures: Provide adequate length of conductors. Train the conductors to terminal points with 24-inch extra cable neatly looped and secured properly. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to radii smaller than allowed.

I. Separation of Wires: Comply with ANSI/TIA/EIA-569A rules for separation of unshielded copper voice and data system cables from potential EMI sources, including electrical power lines and equipment and NEC Article 800-S2.

J. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

K. Cables for data and voice shall be installed and terminated exactly as shown or described in the manufacturer's instructions.

L. Standards for each type of cable are very specific. Cable length, the bending radius of each turn, cutting back the sheath, length of untwisting and termination of the individual wires, stripping of the insulation displacing connections to the push-on terminals shall be performed strictly per manufacturer's instructions and any applicable standards.

M. Work area communications outlets shall be installed as shown on walls, floor or ceilings.

N. Jacks shall be installed as depicted on technology detail plans. Questions or discrepancies shall be reported to the owner.

O. Devices installed in the school will be of the same "Type and Manufacture".

P. All cables shall be routed in large groupings, through main hallways, until cable can be distributed directly to the communication outlet. Route individual cables to the appropriate outlet locations in accordance with all standards described herein.

Q. In suspended ceilings and corridors cable shall be bundled by type using Velcro cables ties snug, but not deforming the cable geometry and be supported via approved "J" style hooks attached to the existing building structure at a maximum of four (4) foot intervals. Use of ceiling tiles, grid or hanger wires for support of cabling is prohibited.

R. Do not install random or diagonal cable runs except for the reasons specified in item A above. Cable turns and bends shall be made at 90-degree angles whenever possible, but maintaining manufacturer's requirements for bending radius at all time.

S. All cables, which enter conduit stubs of technology outlets in fixed wall locations, shall be installed with a minimum of a 3'service loop of cable secured above the ceiling where the cable enters the conduit at each outlet. A 3' service loop of cable shall also be provided in the cable tray above the data patch panel racks. Provide a service loop of cabling for each cable installed above the ceiling

T. All cables which penetrate a steel stud or steel wall cap, wall section and where a cable enters a conduit shall be protected from damage with a "stud liner".

U. All cables entering power poles, surface mounted raceway, or other cable management systems shall be protected from damage.

V. Cabling shall be extended between floors utilizing inter-floor conduit provided under 26 00 00. See network riser drawing for cable pathways.

W. Conduit and sleeves provided as a means of routing cables between various rooms and floors, and those which remain (empty) as spare, shall be sealed with an approved fireproof, removable safing material. Sleeves, which pass vertically from floor to floor, shall be sealed in a similar manner using an approved re-enterable system. Additional penetrations through rated assemblies necessary for passage of wiring shall be made using an approved method, coordination with the General Contractor and permanently sealed after installation of cables.

X. Meet all requirements regarding use of cable in return air plenums (SEE 1.2.C. above) and in raised floor systems. Provide wiring that complies with all applicable state, local building codes, and the National Electrical Code. All cables run in raised floor systems with forced air-cooling shall meet the requirements of Article 645, "Electronic Computer Data Processing Equipment" of the NEC.

Y. Cables installed partially or fully within the MDF and IDFs are to be routed through and secured in the cable tray wherever possible. Cables placed in the cable tray are to be laced or tie wrapped with Velcro tie wraps frequently to keep them neatly bundled and not permitted to shift from one side of the tray to the other as they are routed in the tray.

Z. Provide one voice station cable (Cat6A) from the MDF (home run) to EACH elevator equipment room. Route cable to elevator control cable termination in elevator equipment room as noted on drawings. Leave 30 feet of slack for connection by subcontractor responsible for the elevator phone connection. Terminate, label and crosswire elevator phone and connect cable to the line provided by Local Exchange Carrier. Verify proper room and location with elevator subcontractor.

AA. Secure all equipment racks with threaded rod to cable tray (if installed) above racks.

3.8 GROUNDING

A. Installation

1. The communications subcontractor of this section shall provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, EIA/TIA 568, EIA/TIA 607, state and local codes, and to requirements specified herein. Codes shall be complied with as a minimum requirement, with qualification standards prevailing when they are more stringent.

B. Bonding

1. Metallic conduits, wireways, metal enclosures of busways, cable boxes, equipment housings, all racks and all non-current carrying metallic parts of the installed communications services shall be grounded. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor. A code sized green insulated copper grounding conductor shall be included in nonmetallic conduits, and each end shall be terminated on suitable lug, bus, or bushing.

2. All conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

3. Each metallic raceway, pipe, duct and other metal object entering the buildings shall be bonded together and all conduits entering the building shall be labeled. The communications subcontractor shall use #6 AWG copper conductors.

4. The communications subcontractor of this section shall bond communications equipment and busbars separately.

5. The electrical subcontractor shall install the main telecommunications grounding bus bar.

6. Provide appropriate ground for Directv system that is to be roof mounted. Cable pathing for Directv system shall be in 2” conduit as shown on the drawings in the MDF.

C. Signal Reference Grounding and Bonding

1. Each identified communications space within a building shall have a common signal reference ground. The signal reference ground shall conform to the following:

   a. Within the building, all communication spaces shall be separately bonded to each other and connected to the primary building ground in accordance with the provisions of EIA/TIA 607. The communication ground shall not ground any other equipment or be connected to any potential high voltage source. All racks, frames, drain wires, and all installed communication equipment shall be grounded to this common reference ground only.

   b. Communications subcontractor of this section must provide, as a minimum, a continuous #6 AWG green electrical conductor connected to a 1/4" x 4" x 5.25" telecommunications grounding bus bar (TGB) 6" AFF on the plywood backboard of each IDF and the TV Studio to terminate chassis, racks, and other equipment grounds, unless otherwise specified.

   c. The ground wires from each individual IDF and the TV Studio Head End and Control Room shall be routed directly to the main telecommunications ground

bus bar in the MDF room, terminated and bonded together via a telecommunications main grounding bus bar (TMGB) of minimum 1/4" x 4" x 12" dimensions. This point of single reference for all closets in a building shall in turn be grounded with a minimum #0 ground conductor to an acceptable building ground of 5 ohms or less. An acceptable building ground for signal reference is the building service entrance ground. Electrical subcontractor must supply the grounding bus bar.

D. Riser / Tie Cabling Grounding

1. There shall be no bonding between the entry cable and the inside riser or distribution cable.

2. All riser and tie cable shields shall be bonded into a single continuous path end-to-end and grounded on each floor in which pairs leave the sheath. Cable shields shall be grounded to the signal reference ground provided in each telecommunication space.

E. Field Tests

1. As an exception to requirements that may be stated elsewhere in the agreement with the District, the Inspector shall be given 5 working days notice prior to each test. The communications subcontractor of this section shall provide all test equipment and personnel and shall provide written copies of all test results.

2. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.

3.9 CLEANING

During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.10 COMPLETION

General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.

Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.11 TESTING AND ACCEPTANCE CRITERIA

A. Fiber Optic Cabling

1. Scope of Certification Testing

a. Each fiber optic data cable and associated outlet/connector shall be 100% identified and tested. It is the responsibility of the communications subcontractor of

this section to ensure the design/equipment provided/methods used provides acceptable total link loss to ensure a high performance 10GB backbone.

2. Certification Tests

   a. At a minimum, provide the results from the following performance tests on all installed fiber optic data cabling as outlined in ANSI/TIA/EIA-568-B.3-2000, along with the respective addenda, ANSI/TIA/EIA 526-A and TIA 568-B.1. MM fiber shall be tested at 850nm and 1300nm in accordance with ANSI/TIA/EIA 526-14A method B and SM fiber shall be tested at 1310nm and 1550nm in accordance with ANSI/TIA/EIA 526-14A method A.1

   b. Record all fibers length and total attentuation

   c. Note that all of these tests are required for each strand of the fiber optic data cable.

   d. In addition to these, any performance tests required by the cabling product vendor for issuing and honoring the required 15-year warranty must also be performed.

   e. Approved accuracy testing equipment must be used for all tests.

B. UTP Cabling (Data/Voice/WAP/CCTV, Other)

1. If cable manufacturer requires field AXT testing for its Cat 6a solution/warranty, Communications Subcontractor is to test to the TIA-568-B.2-10 and TIA 568B.1 permanent link testing standards and the following requirements within this specification.

2. Cabling systems shall meet or exceed the electrical and transmission characteristics of the systems specified.

3. Cable segments and links shall be tested from both ends of the cable for each of the construction phases. (Verify that cable labeling matches at both ends).

4. The system shall not be considered certified until the tester has acknowledged that the performance of the physical layer of the system has been fully tested and is operational at the completion of the installation phase.

5. After the installation is complete, in addition to any other required testing as described herein, and at such times as the Owner/Engineer directs, the communications subcontractor shall be present while the Owner conducts an operating test for approval. The installation shall be demonstrated to be in accordance with the requirements of this specification. Any defects revealed shall be corrected promptly at the communications subcontractor's expense and the tests performed again.

6. After review of the completed test results, the Owner reserves the right to retest cables, utilizing the communications subcontractor's tester and the communications subcontractor's labor.

7. Alien Crosstalk Testing Preparation:

   a) Alien Crosstalk (AXT) testing measures the unwanted noise coupled to the cable being tested (called the "Victim" or "Disturbed") by six surrounding cables (called "Disturbers"). Two tests need to be performed: the Power Sum Alien Near-end Crosstalk (PSANEXT) test and the Power Sum Alien Attenuation-to-Crosstalk Ratio, Far-end (PSAACRF) test. Results for the remaining AXT tests are taken as part of these two, so although they are not directly provided, a "pass" result for PSANEXT and PSAACRF ensures passing results for AACRF, AFEXT, ANEXT, and PSAFEXT. A 2% sample of the installed cables is typically recommended: testing the longest cables in the installation will provide the most meaningful results.

b) AXT testing requires special planning, equipment and training:

1. AXT tests are time consuming. Budget AXT test time into the project bid.

2. Handheld test instruments (field testers) require an adjunct AXT module.

3. A laptop computer is also used with the field tester.

4. The field tester's AXT application software must be loaded onto the laptop.

5. Installation personnel will require training prior to performing AXT testing.

8. Field Testing Equipment: Submit during shop drawing review on the testing equipment to be utilized on this project. The communications subcontractor shall test all cables installed under this Section.

a) Category 6a Testing Equipment:

1. Testing shall be accomplished using a UL Level IV field tester capable of testing to 500 MHz. Ensure that the tester has any necessary hardware or software upgrades, including AXT testing capabilities for testing Cat 6a installations.

2. Provide factory calibration report of field test equipment.

9. Testing Procedures:

a) Testing shall conform to the TIA 568B.2-10, TIA 568B.2 and TIA-568-C.2 standards.

b) Testing will be to the Permanent Link Test Parameters.

c) A 2% sample of the installed cables is typically recommended: testing the longest cables in the installation will provide the most meaningful results.

d) Tests shall be based on each pair of conductors and not the aggregate multiple pair results.

e) Test cable segments end-to-end, from the telecommunications room horizontal patch panel/cross connect block panel to each work area outlet and from each telecommunications room backbone patch panel/cross-connect block panel to respective main cross connect, and from the work area outlet to the main cross-connect (through patch cables or cross- connect wiring) with a Signal Injector, Graphical Link Testing Meter and Time Domain Reflectometer (TDR) for compliance to latest TIA performance requirements.

f) Provide report indicating failures and what actions were taken to ensure a passing horizontal cable and its terminations. Any cable failing the certification test (Fail, Fail* or, Pass*) must have remedial work done to provide a full pass test result; Remediation may include retermination or replacement of the cable, which fails. No cables passing within tolerance only (Conditional Pass*) will be accepted. Remedial work shall be at no cost to the Owner."

C. Test Plan

1. All test equipment, test procedures, and testing techniques shall be specified in the acceptance test plan and will require approval prior to execution.

2. Tests shall be conducted by the communications subcontractor of this section in accordance with the approved Test Plan.

3. The purpose of this testing is to verify that the installed system meets all specified attenuation and bandwidth requirements and is capable of being used for its intended purpose.

4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District's technical representative for approval, prior to shipment to the site.

5. The communications subcontractor of this section shall prepare a test plan which provides a detailed outline of all testing to be accomplished.

6. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones), specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

D. Test results:

1. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test. The tester shall be capable of storing test data in either internal or external memory. The external media used shall be left to the discretion of the user.

2. Test results saved by the tester shall be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.

3. Optional formats of data reporting are: comma separated variable (.csv), Portable Document File (.pdf) or compatible, plain text (.txt), or hypertext markup language (.html/.htm).

4. Test Results shall include the following:

   a) Applicable room number of jack location (room number per Contract Documents)
   b) Applicable Telecommunications Room number
   c) Circuit I.D. number with corresponding jack identifier
   d) Wire Map – shall include the following:
      1. Continuity to the remote end
      2. Shorts between any two or more conductors
      3. Crossed pairs
      4. Reversed pairs
      5. Split pairs
      6. Any other miswiring
   e) Length
   f) Insertion Loss
   g) Near-end Crosstalk (NEXT) Loss
   h) PS-NEXT (Power Sum Near End Cross Talk)
   i) FEXT (Far End Crosstalk)
   j) ELFEXT (Equal Level Far End Cross Talk)
   k) PS-ELFEXT (Power Sum Equal Level Far End Cross Talk)
   l) Propagation Delay

m) Delay Skew
n) Return loss
o) PSFEXT (Power Sum Far End Crosstalk)
p) PSACRF (Power Sum Attenuation to Crosstalk Ratio, Far End)
q) AACRF (Alend Attenuation to Crosstalk ratio, Far End)
r) AFEXT (Alien Far End Crosstalk)
s) ANEXT (Alien Near End Crosstalk)
t) PSANEXT (Power Sum Alien Near End Crosstalk)
u) PSAACRF (Power Sum Alien Attenuation to Crosstalk Ratio, Far End)

END OF SECTION

Section 27 21 33

DATA COMMUNICATIONS WIRELESS ACCESS POINTS
(FILED SUB-BID REQUIRED AS PART OF SECTION 26 00 01)

PART 1- GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 - General Requirements.
   1. Work of this Filed Sub-Bid includes all individual specification sections listed in Section 26 00 01

1.2 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the bidder responsible for all work of this identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.3 SUMMARY

A. Work Included. The scope of work of this Section consists of the procurement of all wireless network electronics and materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all equipment work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows:

   1. Provide, install, program and test all wireless equipment, modules, mounts, power supplies, chassis, power cords, and licenses that create the wireless network environment. Configure equipment as per Owner direction.
   2. Provide, install and test wireless access points in OWAP and WAP4 locations shown on the drawings. Verify with the owner these locations are acceptable, and adjust as per owner direction.
   3. All wireless access points shall be installed below the ceiling tiles unless noted otherwise.
   4. Provide heat map of wireless coverage when installation is complete. Adjust/move WAP

devices to achieve acceptable coverage in accordance with owner directions.

B. The work of this Section is shown on Technology Drawings numbers designated by a T.

C. No corridors, classrooms or spaces are air plenums. No cabling is required to be plenum rated.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

C. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. Specialty Equipment: DIVISION 11, “EQUIPMENT”

2. Field Painting: DIVISION 9, “FINISHES”

3. HVAC Equipment: DIVISION 23 00 00, “HVAC”

4. Electrical: DIVISION 26 00 00, “ELECTRICAL”

5. All SECTIONS of DIVISION 27

D. Unless otherwise indicated, the following work is not included as part of the Communication Subcontracor’s responsibilities in this SECTION, except for coordination, and is to be performed by others as indicated:

1. Empty conduits to accessible point above or below floor shall be provided by the electrical subcontractor.

2. Floor boxes and poke through devices shall be provided by the electrical subcontractor.

3. Standard device boxes with plaster rings for data shall be provided and installed by the electrical subcontractor.

4. Clock system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications Subcontractor.

5. Telephone system, installation and cross connections and devices provided by the owner.

6. Speaker/paging system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications Subcontractor.

7. Structural blocking to support wall and ceiling mounted equipment shall be provided by the General Contractor.

8. Computers and monitors and final connections to outlets shall be provided by the Owner.

9. Interface with public utilities telephone service shall be arranged and provided by the Owner.

10. Wide Area Network connections shall be arranged and provided by the Owner.

11. CATV service and connections to installed systems shall be arranged and provided by the Owner.

12. Single-Mode and Multimode fiber, terminations and patch cords

13. Equipment racks

14. Network PoE switches to power and connect WAP devices shall be provided and installed by the Owner.

E. The installation, operating cost and maintenance of the controlled environmental conditions, for equipment located on site, as cited by the manufacturer, NFPA 70B, or as specified in these specifications shall be the responsibility of the General Contractor.

1.5 SYSTEM DESCRIPTION

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the Aerohive wireless equipment listed below.

Manufacturer:	Item:	Part Number:
ADTRAN	CEILING MOUNT WIRELESS ACCESS POINT	1700954F1
ADTRAN	WALL MOUNT WIRELESS ACCESS POINT	1700955F1
ADTRAN	OUTDOOR WIRELESS ACCESS POINT	1700952F1
ADTRAN	LICENSES	NA

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.
   1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

C. Coordination: Coordinate device locations in equipment racks with other trades and the Owner.

1.6 REFERENCE SPECIFICATIONS, STANDARDS AND CODES

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. Work shall meet or exceed the standards and procedures of the following:

American National Standards Institute (ANSI)
Building Industry Consulting Service International (BICSI)
National Electrical Manufacturers Association (NEMA)
Telecommunications Industries Association (TIA)
Electronic Industries Association (EIA)
National Electrical Safety Code (NESC)
Institute of Electrical & Electronics Engineers (IEEE)
Underwriters Laboratories (UL)
National Fire Protection Association (NFPA)
American Standards Association (ASA)
Federal Communications Commission (FCC)
Occupational Safety and Health Administration (OSHA)
American Society of Testing Material (ASTM)
National Electric Code (NEC)
Americans with Disabilities Act (ADA)
In the event of conflicts, the more stringent provisions shall apply.

1.7 COORDINATION

A. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Communications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Communications Subcontractor and Architect. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Communications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.8 SUBMITTALS

A. General: Architect may require submittal submission within 45 days of bid award. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, Section 01300 and Section 26 00 00. Submittals shall be made as one complete package.

B. The Submittal shall include, but shall not be limited to the following:

1. Product Data for each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned plan and elevation views of components. Provide an index and tabulated pages referencing the equipment in the specification. Any submittal received without a full index and tabulated pages shall be returned without action.

2. Provide qualification/certification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Provide evidence of applicable registration or certification.

3. Field test and observation reports from qualified inspecting and testing personnel indicating and interpreting test results relative to compliance with performance requirements of the installed systems.

4. Final schedule of cables as specified in Part 3.

5. Evidence of listing of products specified to be listed in the "Quality Assurance" article.

7. Shop drawings, prepared in AutoCAD, readable in AutoCAD Release 2007 or newer, detailing the cabling systems.

C. Shop drawing submittals shall include but shall not be limited to the following:

1. As Builts indicating the following:

a. Locations of all devices and cabling with identification numbers and MAC addresses of equipment.

b. Cable schedule showing WAP identifier, MAC address, serial number, outlet number and corresponding patch panel port identifier.

2. System riser diagram indicating general arrangement of interconnections between system components on each floor of the building, identifying number and type of deivces.

3. Rack risers showing controller locations with closet numbers.

D. Device Schedules: Prior to substantial completion, prepare and submit location schedules for each of the devices installed under this section describing the as-built condition of the systems. Prepare device schedules in tabular form. Include the following information in each schedule:

1. Device Schedule:

a. Serial number
b. MAC address
c. Location

d. Faceplate port number and service closet port number

e. Initial Test results.

E. It is intended for the Submittal data to be complete and accurate at the first submission. If the submittal is returned marked “Resubmit” only one additional submission will be permitted. IF THE SECOND SUBMITTAL IS NOT ACCEPTABLE, OR IF THE SUBMITTAL IS NOT MADE WITHIN THE SPECIFIED TIME FRAME, THE RIGHT OF SUBSTITUTION AND SELECTION WILL BE LOST. THE OWNER WILL SELECT THE SPECIFIED ITEM. THAT ITEM IS TO BE PROVIDED AND SHALL BE PROVIDED AT NO ADDITIONAL COST.

F. A minimum period of 15 working days, exclusive of transmittal time, will be required in the Owner’s office each time Shop Drawings, Product Data, layout drawings, catalog data and brochures are submitted or resubmitted for review. A minimum period of 20 working days exclusive of transmittal time will be required for reviewing substitute materials or manufacturer. These time periods shall be considered when scheduling the work.

G. If proposed equipment deviates from the Specification or Drawings, indicate in writing on Company letterhead those differences and provide sufficient data to justify acceptance. FAILURE TO INDICATE DEVIATION OR SUBSTITUTIONS IMPLIES FULL COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

1.9 RECORD DRAWINGS

Provide Record Drawings in accordance with Division 1 for requirements regarding Project Record Documents.

“As- Built” record documentation for telecommunications work shall include:

System function diagrams.
Communications flow diagrams.
Manufacturers’ description literature for equipment.
Connection and programming schedules as appropriate.
Equipment material list including quantities.
Spare parts list with quantities.
Details not on original Contract Documents.
Test Results
Warranties
Release of Liens

Operation and Maintenance Manual:

Refer to Section 01 33 00 - Submittals for requirements pertaining to Operation and Maintenance Data.

The Communication Subcontractor shall submit manuals in accordance with Division 1 containing manufacturers’ brochures of items installed by the Communication Subcontractor.

The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

Provide the following additional information for each electronic system. Information shall be edited

for this project where applicable.

Operations manuals for components and for system as a whole.

Maintenance manuals for components and for system as a whole.

Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.

List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.

Emergency instructions for operational and maintenance requirements.

Delivery time frame for replacement of component parts from suppliers.

Recommend inspection schedule and procedures for components and for system as a whole.

Complete “Reviewed” shop drawings and product data for components and system as a whole.

Troubleshooting procedures for each system and for each major system component.

1.10 QUALITY ASSURANCE

Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect.

A. Bidder Qualifications: Bidder must be certified by the manufacturer to procure, install, configure and warrant listed products.

B. Comply with the following:

1. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard.

2. ANSI/TIA/EIA-568-B.1, Commercial Building Standard for Telecommunications Cabling Standard Part 1 General Requirements, 2001.

3. ANSI/TIA/EIA-568-B.2, Commercial Building Standard for Telecommunications Cabling Standard Part 2, Balanced Twisted Pair.

4. ANSI/TIA/EIA-568-B.3 and B.3-1, Optical Fiber Cabling Components Standard

5. ANSI/TIA/EIA-526-7 Measurement of Optical Power Lossof Installed Single-Mode Fiber Cable Plant.

6. ANSI/TIA/EIA-14A Measurement of Optical Power Lossof Installed Multimode Fiber Cable Plant.

7. ANSI/TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

8. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

9. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

10. BISCI Telecommunications Distribution Methods Manual Standards, Volume 12.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.

D. Work Coordination: Coordinate Work of this Section with School’s provided telephone switch and telephone instruments, planned equipment, wide area network (WAN), and the Technology Director of the School District.

1. Record agreements reached in meetings and distribute record to all participants in the meetings.

E. Communications subcontractor must be certified by the manufacturer to provide, install, service and warrant wireless system. Provide proof of manufacturers’ certification for systems to be installed.

1.11 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Communications Subcontractor under other requirements of the Contract Documents.

B. Provide 3 year warranty for parts and labor, to include travel and expenses.

C. The warranty shall cover material, services, software assurance, and operation of the wireless system.

D. All test results and warrantees shall be submitted to the Technology Director (Minimum two (2) copies of test results will be required in electronic format). Submittals must be received prior to substantial completion.

E. Uncertified communications subcontractors will be required to remove equipment and pay for replacement by a certified communications subcontractor at no additional expense to the Owner.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be suitably packaged by manufacturers to prevent damage during shipment and handling. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area. Do not install equipment until the IDFs, MDF and other areas can be secured and controlled.

PART 2 - PRODUCTS

MATERIALS:

Manufactured Products:

Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.

Equipment Assemblies and Components:

Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

Components shall be compatible with each other and with the total assembly for the intended service.

Moving parts or elements of equipment of the unit normally requiring lubrication shall have means provided for such lubrication and shall be adequately lubricated at the factory prior to delivery.

2.1 PROTECTIVE ENCLOSURE

A. Provide protective enclosure for all wireless access points installed in the gym (qty 4).

2.2 WIRELESS ACCESS NETWORK EQUIPMENT

A. Provide the following in the quantities listed:

Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the Aerohive wireless equipment listed below.

Manuf:	Item:	Part Number:	Qty:
ADTRAN	CEILING MOUNT WIRELESS ACCESS POINT	1700954F1	111
ADTRAN	WALL MOUNT WIRELESS ACCESS POINT	1700955F1	6
ADTRAN	OUTDOOR WIRELESS ACCESS POINT	1700952F1	2
ADTRAN	LICENSES	NA	

B. The products listed above shall be configured and installed by the communications subcontractor of this section. Mount all wireless access points at a WAP4 symbol below ceiling tiles unless wall mounted or noted otherwise. Provide green Cat6a patch cords of sufficient length and connect wireless access points to WAP4 outlet. Provide 6 wall mount kits for the 6 wall mount WAPs. Mount non wall mount WAPs on exposed ceiling where a WAP4 is shown on the exposed ceilings of the reflected ceiling plans. Provide and install all mounting brackets and adapters required for various mounting surfaces.

PART 3 - EXECUTION

3.1 PROTECTION OF SYSTEMS AND EQUIPMENT

Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.

Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

3.2 WORK PERFORMANCE

Coordinate location of equipment with other trades to minimize interference.

3.3 ACCESS TO EQUIPMENT

Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.

Working spaces shall be not less than specified in the National Electrical Code for voltages specified.

Where the ARCHITECT and OWNER determine that the Communications Subcontractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the ARCHITECT and OWNER, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CABLE TERMINATIONS AND DRESS

Installation of signal, video, communication and control conductors shall adhere to the following:

Cables shall be dressed, labeled and tie wrapped in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the Communications Subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

Cables shall be secured to equipment cabinet backboards, console members or to other system

components using cable clamps and wraps. The Communications Subcontractor shall furnish and install cable support posts to facilitate system installation.

Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

3.5 EXAMINATION

A. Examine pathway elements to receive cable. Check raceways, wire ways, cable trays and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Prior to the start of actual installation, the communications subcontractor shall review the exact location of all cables, outlets, and equipment with the Owner, Construction Manager and the suppliers of related equipment.

C. The communications subcontractor shall coordinate the equipment installation with the installation of raceways to eliminate potential damage to cables.

3.6 INSTALLATION

A. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturers. Maintain recommended manufacturer's minimum bend radii of all UTP and fiber optic cabling at all times.

A. Devices installed in the school will be of the same "Type and Manufacture".

3.7 CLEANING

During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.8 TRAINING

Provide 4 hours of training on wireless controller operation, configuration and modification.

3.9 COMPLETION

General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

Results Expected:

Systems shall be complete and operational and controls shall be set and calibrated. Testing,

start-up and cleaning work shall be complete.

Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.10 TESTING AND ACCEPTANCE CRITERIA

A. Test Plan

1. The communications subcontractor of this section shall prepare a test plan which provides a detailed outline of all testing to be accomplished. Submit test plan to Owner for approval.

2. Tests shall be conducted by the communications subcontractor of this section in accordance with the approved Test Plan.

3. The purpose of this testing is to verify that the installed system meets all bandwidth requirements and is capable of being used for its intended purpose.

4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District's technical representative for approval.

5. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones), specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

B. Test Results

1. Each test sheet shall have a sign-off blank for the communications subcontractor of this section, as well as the District's technical representative. Copies of the completed test forms or test results shall be delivered according to the shop drawing procedures.

2. The communications subcontractor of this section shall maintain an accurate test record during all field tests. Any communication subcontractor-developed format for recording test data shall be submitted for approval as part of the test plan.

END OF SECTION

Section 27 40 00

AUDIO - VIDEO COMMUNICATIONS
(FILED SUB-BID REQUIRED AS PART OF SECTION 26 00 01)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 - General Requirements.
   1. Work of this Filed Sub-Bid includes all individual specification sections listed in Section 26 00 01

1.2 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the bidder responsible for all work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.3 SUMMARY

A. Work Included. The scope of work of this Section consists of the designing, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:
   1. Classroom local sound, interactive flat panel, and voice amplification/mixing system.
   2. Conference, small group rooms, and Media Center (2 media center locations): local sound, interactive flat panel, and voice amplification/mixing system.
   3. Local sound systems for the Gymnasium, Cafe (2 café locations, one floor 1 one floor three).
   4. Main entry video wall, 3x2 configuration
   5. The following faceplate (See T2.0 and T2.1) cabling, terminations and installation responsibilities are part of this section: Microphones (M in a circle, with a number subset next to circle for more than one jack on the plate), HM (hanging microphones), SPr, SPr2, T1A, B1, B2, B3, B4, B5, V1, V2, V3, V4, V6, V7, VA. All faceplates shall be stainless steel.

6. Various cabling termination for systems to include low voltage wire for complete and functional systems.
7. All low voltage control wire shall be one continuous run. No splices are permitted.
8. Provide and install a roof mounted AM/FM antenna cabled to the MDF then distributed to all AM/FM tuners specified herein to allow for a clear radio signal within the building. Provide appropriate distribution and amplification for a fully functional system.
9. T2.8 and T2.9 equipment, related work, cabling and other equipment/components required for design intent unless noted otherwise on those drawings.
10. All ceilings designated on reflective ceiling plan drawings as black shall have black speakers installed.
11. High lumen projector and two screens in floor one café, for presentation of material both inside, and outside the café.

B. Actual control room and rack layouts will be based upon the specific designs submitted by the communications subcontractors. Needs for audio processing equipment, specific speakers, and other equipment will be dependent on actual product manufacturers and communications subcontractors design. Communications subcontractors shall coordinate room layout, actual speaker and equipment placement, programming options, and control panel screens with owner prior to installation.

C. Provide and install:
1. Assembly and setup of the systems for normal operation, testing, and training of operators and users.
2. Permanently installed sound reinforcement systems and equipment racks including the processing equipment, compact disc player, iPod player, audio & video equipment, mixers, and amplifiers.
3. Equipment racks, and power supplies.
4. New microphones and microphone jacks.
5. All speakers. Gymnasium systems shall include all rigging hardware necessary to mount speakers. Conference Rooms, Band and Chorus rooms, Classrooms, and both Student Dining shall use ceiling mounted speakers, some of which are pendant mounted. Library shall utilize wall mounted speakers where shown.
6. All labor, programming, design, tuning, cabling, terminations and system configuration.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 05 31 00 – STEEL DECKING See section for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking.

C. The following related work or material shall be provided under the designated trades and under the listed SECTION:
1. SECTION 11 52 13 - PROJECTION SCREENS
2. SECTION 12 30 00 - MODULAR CASEWORK
3. SECTION 26 00 00 - ELECTRICAL All electrical work related to items in this Section and coordinate input to auditorium sound system for muting purposes upon fire alarm activation.
4. SECTION 10 11 16 – MARKERBOARDS
5. SECTION 27 70 00 – Video Distribution System (RS-232 cabling for interactive flat panels in classrooms and other interactive locations, faceplate connections (T1, V) for STB). Coordinate cable pulls with 277000 subcontractor such that the RS-232 cable is pulled with the 274000 cabling. RS-232 cable provided by 277000 and pulled with 274000 cabling by 274000.

6. SECTION 11 61 00 THEATER AND EQUIPMENT – Auditorium sound/projection system

1.5 SYSTEM DESCRIPTION

NOTE: ALL wireless systems, (such as microphones, assistive listening, touch panels) specified herein require the communications subcontractor to provide appropriate amplifiers, distribution amplifiers, antennas and antenna placements, cabling, rigging, and related components to ensure full space coverage for microphones and assistive listening systems, and full use of the wireless touch panels (and other devices as specified 'wireless') within the space. Provide additional antennas, cabling and equipment to ensure full space coverage.

A. Classrooms - Typical: Classrooms locations shall be equipped with audio and video equipment to assist the instructor. System includes local audio reinforcement, wall mounted interactive flat panel, and voice amplification/mixer equipment. Desktop and laptop computers will be provided by owner prior to system acceptance.

B. Interactive Conference Rooms - Typical: Interactive Conference Room locations shall be equipped with audio and video equipment to assist the presenter. System includes local audio reinforcement, wall mounted interactive flat panel, and voice amplification/mixer equipment. Desktop and laptop computer will be provided by owner prior to system acceptance.

C. Gymnasium
   1. Sound Reinforcement System with program loudspeakers. System must be configured to patrician for separate audio combining to support: a full gym; ½ gym and ½ gym; ¼ gym and ¼ gym and ½ gym configurations.
   2. Rack mounted multi-channel sound mixer, and source audio equipment.
   3. Wireless microphone system and assistive listening system

D. Café (two system locations, floor one and floor three)
   1. Sound Reinforcement System with program loudspeakers.
   2. Rack mounted multi-channel sound mixer, and source audio equipment.
   3. Wireless microphone system and assistive listening system.
   4. Floor one system has high lumen projector and front and rear projection screens.

E. Video wall in main entry, 3x2 configuration with equipment cabinet located in library behind video wall.

F. Coordination: Coordinate device locations with furnishings and equipment.

1.6 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit 3 copies of the following as part of the submittals.
   1. A list describing at least 5 installations comparable in scope and nature as specified. Include the name, current position, address, and telephone number of a representative of each installation owner.
   2. Provide a listing of test equipment including a list showing procedures and service contacts.
   3. A complete list of quantities, including materials, components, devices, and equipment required for the Work. Tabulate the list of quantities for the components of each system as specified, and provide the following information for each item listed:
      a. Quantity.
      b. Description.
      c. Manufacturer's name and model number.
      d. Corresponding specification section and article number.

      Non-tabulated and indexed submittals shall be returned without action.

4. Corrected items as applicable for resubmitted, as specified above.
5. Complete, comprehensive, single-line diagrams in computer aided drafting (CAD) format including equipment, devices, connectors, wiring, and wire numbering completely identified. Include label designations and locations. One-Line signal flow drawings shall be submitted with specific equipment bid.
6. Complete, scaled (1" = 1'-0" minimum) in CAD format, equipment rack elevation drawings, including equipment designation, manufacturer's name, model number, rack location, and rack designation, and sample touch screen layouts for the integrated control systems.
7. Complete catalog cut sheets and manufacturer's literature.

B. Closeout Submittals:
1. Copy of FCC license for Hearing Assistance System FM transmitters.
2. Copy of certificate of cables complying with fire retardant requirements.
3. Closeout Submittals: Submit 3 record drawings to the Owner.
4. Owners/Operations manuals for all installed equipment. Provide in a three ring binder.
5. Updated one line system flow diagrams.
6. A simple to follow laminated placard on the inside of the door of each sound system showing how to turn on and use the basic sound system.

1.7 QUALITY ASSURANCE

A. Manufacturers' Requirements:
1. Manufacturer's products shall have been satisfactorily used in similar service for a minimum of 3 years.

B. Bidder Qualifications:
1. A firm with a minimum of 5 years successful installation experience similar in scope with this project.
2. Bidder shall be primarily engaged in the procurement, design, installation, and maintenance of commercial duty audio and video systems. Bidder must be certified by the manufacturer to procure, install, configure, program and warrant the equipment.
3. Bidder must hold a valid CTS-D Certification from the International Communications Industries Association.
4. Bidder installing technicians must hold a valid CTS-I Certification from the International Communications Industries Association.
5. Bidder installing technician shall be certified by the video and audio control system manufacturer if programming of control equipment is required.
6. Bidder must provide a CTS Certified project manager that provides weekly progress reports to owner on installation progress, attends job meetings, and visits the site at least weekly during equipment installation.

C. Code Compliance: Comply with national, state, and local electrical and structural codes as applicable to installation and construction of the sound reinforcement system.
D. Provide equipment listed and labeled by Underwriters Laboratories (UL).
E. Sound Pressure Level (spl): Provide a range of 90 to 95 dB spl for the listeners in any location in the Gymnasium and both Cafes. Comply with ANSI S13-1971 (R1986).
F. All wiring shall be in raceways and conduits.
G. All equipment AC power shall have lightning surge protection.

1.8 WARRANTY

A. Communications subcontractor shall warrant all work free from defects in materials and labor for 36 months from the date of substantial completion. Provide minimum 3-year parts and labor warranty for all systems/components.
B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by

damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.
   1. Provide material, devices, equipment, and personnel necessary for repairs.
   2. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

D. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

E. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

1.9 DELIVERY, STORAGE AND HANDLING

A. Handle equipment components carefully to prevent breakage, denting, and scoring the finish.

B. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

C. Store equipment in a clean, dry space, in original cartons and protect from dirt, physical damage, weather, and construction traffic. Protect electronic components from dust debris and water.

1.10 SEQUENCING

A. Furnish a listing of test equipment presently owned and to be used for this project. Include make, model number, serial number, and the date of last equipment calibration. Test equipment shall be calibrated within the past 24 months of contract award.

B. Test Equipment: Furnish, store, and maintain the following test equipment at the job site for both routine and performance testing of this work. After testing, remove equipment from the site.
   1. Oscilloscope B/W-130Mhz, Sens-1mV/cm
   2. Digital Multi-meter 1 percent accuracy
   3. Analog O.M. Simpson 260 or Fluke equivalent
   4. Function Generator B/W-1MHz, Distortion <1 percent
   5. Real Time Analyzer 1/3 Octave with calibrated microphone
   6. Pink Noise Source B/W-20Hz-20KHz
   7. Impedance Meter Range 20Hz-20KHz, 1 Ohm-50KOhm
   8. Impedance Bridge Sennheiser ZP-3 or equivalent
   9. Precision Test mic B & K Model 4006, or equivalent, Omni
   10. Directional microphone.

1.11 OWNER'S INSTRUCTION

A. Provide on-site training to the Owners personnel and technical staff on the use of the audio/visual systems; 8 hours minimum for classroom systems, 8 hours minimum for gym system, 8 hours min for Café systems, 16 hours min for interactive flat panels and classroom systems, 4 hours for video wall system.

B. All training shall be video recorded by communication subcontractor of this section and provided to the owner on DVDs.

C. Provide digital copy of the manual service books (classroom systems, Cafe, video wall and Gym). Provide a full parts list of all equipment delivered.

1.12 MAINTENANCE

A. Manual: Prepare and submit, before acceptance testing, copies of an operations and maintenance manual, neatly bound, indexed and tabulated. Provide 3 copies for the Owner's use. Manual shall include:
   1. Basic power on/off and operational procedures.
   2. Placards in each sound system, on the door or wall, depicting on/off and adjustment procedures & controls
   3. Manufacturer's service literature for each major system component.
   4. A system block diagram with input/output termination's identified including wiring diagrams.
   5. A copy of the verification test report.
   6. Each copy shall contain the systems for the Gym, Café, and video wall and typical classroom setup, to include IPTV control of panels. Coordinate this requirement with the 27 70 00 communications subcontractor.

PART 2 - PRODUCTS

2.1 Classrooms, Conference Rooms, Library, (105 total interactive locations):
   A. General:
      1. Rooms shall be equipped with audio reinforcement, voice amplification, interactive flat panel for video presentation and interactivity. Equipment shall be mounted in a provided permanent fixture in each classroom.
      2. Equipment shall be mounted within the furniture to provide a fixed installation. Connections to devices in teacher desk location will be provided via the classroom technology outlet faceplates (T1). Communications subcontractor must provide all cabling cross connections unless noted otherwise on the drawings.
      3. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment.
   B. Capabilities: The system shall provide the following capabilities:
      1. Ability to activate and control the panel to select media source inputs from the IPTV software. Coordinate connections and functions with 27 70 00 communications subcontractor.
      2. An interactive flat panel that is mounted on the teaching wall of the classroom, which can interact with a desktop or laptop computer installed within the room. The desktop and laptop computers are not part of this specification.
      3. Display of the local desktop or laptop computer (computers provided by Owner).
      4. Distribute audio from source equipment clearly to the entire room.
      5. Amplify and distribute teacher's voice clearly to the entire room.
      6. Display IPTV channels via the IPTV set top box (provided and installed by 27 70 00 communications subcontractor)
   C. Products:
      1. Interactive Flat Panel (provide 105 total; one at every wall mounted V location).
         a. Provide and install an interactive flat panel for the display of 1920x1080 full HD. Panel shall be controlled by RS-232 communications for remote control functions via the IPTV system.
         b. Panel shall be a minimum brightness of 350cd/m^2.
         c. Panel must meet the following specifications:
            1) Integrated PC module
            2) Resolution- 1920 x 1080 min
            3) 70" LCD, LED backlit
            4) 16:9 aspect ratio
            5) 120Hz refresh min
            6) Quad core GPU

7) Input method: finger, glove, stylus
8) Response time <20ms
9) Protective glass: 4mm tempered min, anti-glare
10) Provide and install wall mount
11) Input terminals: HDMI 1.4 x3, VGA, Ethernet, RS-232, audio input and output

d. Provide and install a wall mount and two HDMI 35' cables from panel to back of T1 outlet. All cables shall be terminated on a custom faceplate. All faceplate to owner equipment cabling shall be long enough to extend 4' outside of the cabinet for connection to PC/Laptop to display all source media as shown on the drawings. Provide all necessary mounting hardware for all wall surfaces. Use HDMI cable locks to affix HDMI cabinet cables to the T1 faceplate HDMI jacks.
e. Provide cables and connect two HDMI, LAN and USB to panel inputs. USB cable shall be connected from panel to T1 faceplate
f. Interactive flat panel is part number CTI-5070H+UH10 by Cleartouch Interactive or equal.

2. Speakers
   a. Provide and install four (minimum, see SPr on drawings) ceiling mounted 16-watt ported loudspeakers speakers (2 in conference room ceilings and small group rooms, 2 wall mounted speakers of similar performance in both library locations). Speakers shall be connected to the audio amplifier/mixer to provide sound reinforcement to the rooms. Speakers shall be installed to provide even sound coverage in the room.
   b. Ceiling and wall speaker color shall be white unless ceiling space is shown as black on reflective ceiling plan drawings. If ceiling space is black, provide and install black speakers.
   c. Speaker shall have a frequency range of 90Hz to 16kHZ (+- 3dB).
   d. The speakers shall feature an integrated transformer that allows for 70/100V operation
   e. The tap settings at 70v shall be 1W, 2W, 4W, 8W and 16W.
   f. Speakers are Bose DS16F-043054, alternates by TOA, JBL or equal.
   g. Include tile bridge where required
3. Presentation Camera (provide 25)
   a. Provide 5MP digital presentation camera with a min 8x digital zoom
   b. Camera shall have the following specifications:
      1) 5M pixels
      2) 30 frames per second
      3) AC 120v power source
      4) HDMI or digital DVI Video output. Provide twenty five (25) 6' HDMI cables.
      5) Records voice and video
      6) PC Interface: USB.
   c. Presenter shall be Aver 300AFHD or equal by Smart or Elmo.
4. Voice Amplification System (QTY 105; provide in all interactive locations
   a. Two IR channels with independent volume controls
   b. Four stereo audio inputs with independent volume controls.
      1) Power output 12W per channel (24W total).
      2) Freq Response: 60HZ-20kHZ
      3) Power supply (UL Listed): 24v/2.5A
      4) SNR: >73dB
      5) THD:<1% @ 20W (10W/channel)
      6) Speaker load impedance: 4 ohm/Output
      7) Microphone must be mixed with all other inputs

c. Provide and install equipment with sensitivity adjustment to mute voice amplification system upon a public address announcement or room page. Test PA system to ensure voice amp system is muted in each room. Adjust accordingly.
d. Two audio outputs with level controls
e. Two speaker outputs to power a total of 1-4 speakers
f. 4-band equalizer
g. Infrared sensor/receiver input
    1) The sensor must have the ability to cover a classroom up to 1600 square feet with the capability to add additional infrared sensors for larger or odd-shaped rooms.
    2) Provide and install one (min) ceiling mounted IR sensors/receivers and ensure 100% room coverage for IR microphones with no dropouts. Adjust placement of sensors accordingly. Provide and install additional sensors if required for 100% room coverage.
h. Amplifier volume is controlled via the front panel volume controls
i. The amplifier must contain a page mute function that passively detects the audio signal of a page coming through the PA system without compromising system performance or voiding warranties. As an audio signal is sent to the PA speaker, the page mute function detects that signal and immediately mutes the audio amplifier.
j. The system shall be available with an alternative group of 2 frequencies to allow for a total of 4 compatible channels in a single room or common area.
k. The system shall carry a “No Audio Dropout Guarantee” for enclosed classrooms up to 1600 square feet with ceiling heights of 12 feet or less. Should any audio dropout occur, the manufacturer will correct it at no additional charge.
l. Provide one (1) REDMIKE® microphone (or equal) for teacher use and one (1) REDMIKE® microphone (or equal) as a share transmitter for student use.
m. Voice Amplification System is CAT 855 by Lightspeed or equal

5. USB Active Repeater. Provide at all interactive panel locations. Qty 105.
    a. Cat5e/Cat6 Transmitter and Receiver
    b. 150ft range minimum
    c. Must use Cat5/5e/6 cabling color: GRAY
    d. Built in buffer that actively regenerates usb signals
    e. USB extenders are not acceptable
    f. Provide and install cat5/5e/6 GRAY plugs and cabling at all locations. Provide and install USB cables at all panel locations and at all T1 locations, with 4’ of USB cable outside top of T1 cabinet.
    g. USB-C5E by QVS, alternates by L-Com, CablesToGo or equal
6. Cabling – Provide and install:
    a. All HDMI cabling required. HDMI cabling from faceplates must extend 4’ min outside of T1 cabinet to allow for laptop connection. See T2.9 for cables. Coordinate with 27 70 00 IPTV communications subcontractor.
    b. All audio cabling required. See T2.9. Audio cable to Laptop must extend 4’ outside of T1 cabinet.
    c. Any other cabling required for a complete and operational system
    d. USB cabling from laptop (must extend 4’ outside of cabinet) to USB repeater, Cat6 between repeater devices, and USB cabling from repeater at projector to projector.
    e. Purple patch cord from purple data jack at VB plate to projector.
    f. 6’ 3.5mm to 3.5mm audio cable. Leave in cabinet, connect to voice lift system.

2.2 Café (Floor 1)

A. General:

1. Floor 1 Café shall be equipped with a local sound reinforcement system with distributed program speakers and subwoofers. Speakers shall be mounted in permanent locations as shown on the drawings.
2. Digital signal processors (DSPs) and audio program equipment shall be installed within a 19" full rack to be installed in the specified location.
3. LCD Video projector will be pole mounted as shown on the drawings (V1/D2). Provide lens required for full screen viewing. Projector must be able to display forward and rear projection images.
4. Provide control system with 8.7" min wireless touch panel and controller for all installed equipment.
5. Provide and install for audio muting upon PA announcement, and upon fire alarm activation.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to power-up, select, and control media source materials, and raise/lower projection screen from a wireless video touch panel docked in the rack.
   b. Ability to display video source (IPTV, DVD, and Computer input on faceplate) material using a multimedia projector system.
   c. Ability to distribute audio programming from CD/iPod combination, microphones, video source material, local computer, and building PA system.

C. Products:

1. 8 channel DSP Mixer with AEC at mic / line inputs
   a. The mixer shall have eight mixer input ports.
   b. 3 Standard balanced mic / line inputs
   c. 4 balanced mic / line outputs.
   d. Provide a rack mount bracket.
   e. Unit must be equipped to mute current audio program if building PA system is activated. PA system communications subcontractor to provide program source.
   f. Telephone interface required.
   g. Serial port for third party RS232 Control
   h. DSP is Nexia TC and Nexia VC in quantities needed for design intent, or equal by Clearone or QSC.
2. CD iPod Dock Combination Unit
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4" stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19"W x 3.72" H x 11.73"D

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz.

3. Blue Ray DVD Player
   a. Supports Super Audio CD and DVD-Audio formats
   b. Support Blu-ray 3DTM playback(1)
   c. Network functions, capable of playing YouTube and Netflix video distribution services without a PC, music, photo, and video files stored on a network-connected device such as a PC or NAS.
   d. Support Deep Color, “x.v.Color”, High-Bit-Rate Audio output and HDMI control function
   e. High quality 32-bit/192kHz audio digital to analog converters
   f. High quality 12-bit video digital to analog converter
   g. USB port on the front
   h. Direct Mechanical Ground Construction, to suppress vibration and ensure high-quality HD sound and video
   i. Independent Block Construction, for faithful playback of audio and video signals
   j. Advanced High-bit I/P Scaler, for a more detailed picture and depth in colors
   k. 1080p/24 video output, to bring out the full quality of film
   l. Deep color support
   m. 3-D digital noise reduction
   n. HDMI source direct mode to output native resolution of the disc
   o. Picture adjustments
   p. Gold plated terminals
   q. User friendly GUI
   r. Glo-key remote controller
   s. AMX, Crestron third party control support via RS-232C Custom Integration
   t. Remote In/Out connection
   u. Remote lock mode
   v. Supports Super Audio CD and DVD-Audio formats
   w. Support Blu-ray 3DTM playback
   x. Dolby TrueHD and DTS-HD Master Audio HDMI output
   y. Advanced High-bit I/P Scaler
   z. 1080p/24 video output
   aa. Supports Super Audio CD and DVD-Audio formats.
   bb. Supports Blu-ray discs, DVDs, CDs, Super Audio CDs, and DVD-Audio.
   cc. Plays compressed content such as music and video files. Supports DivX® video files stored on USB memory, DVD-R/RW or other recordable media, MP3 and WMA music files, JPEG files taken with a digital camera, as well as WMV video files and MPEG-AAC music files.
   dd. Versatile Disc Formats Playability
      1) BD-Video
      2) BD-R (BDMV format)
      3) BD-RE (BDMV format)
      4) DVD-Video
      5) DVD-Audio
      6) DVD+R, DVD+RW (Video mode, AVCHD format)
      7) DVD-R, DVD-RW (Video mode, AVCHD format)
      8) Super Audio CD
      9) Audio CD
      10) CD-R, CD-RW
      11) Kodak Picture CD
   ee. Other Features
      1) HDMI resolution select on front panel
      2) Detachable AC cord
   ff. Ports

1) Video
   a) HDMI output x 1
   b) Component output x 1
   c) Composite output x 1
2) Audio
   a) Coaxial digital output x 1
   b) Analog output (2ch, L/R) x 1
   c) Analog output (7.1ch audio out) x 1
3) Control
   a) Ethernet x 1
   b) USB port x 1
   c) RS-232Cx 1
   d) Remote control (IN / OUT) x 1 / x 1

gg. Main Specifications
1) Video
   a) Signal system
   b) PAL/NTSC
2) Audio
   a) S/N
      i. 125 dB
   b) Total harmonic distortion
      i. 0.0008% (2ch, L/R)
   c) Dynamic range
      i. 110 dB
3) General
   a) Power supply
      i. 110 - 240 V, 50/60 Hz
4) Dimensions
   a) W x H x D 434 x 107 x 319 mm (incl. protrusions)
5) Weight
   a) 5.2 kg

hh. Blue Ray player is Denon BDP-2012UD or equal by Marantz or Tascam

4. Speakers Qty 5 indoor, 2 outdoor and 3 Subwoofer
   a. Mount speakers as shown on the drawings, flown from the ceiling.
   c. Speaker parameters:
      1) Frequency response: 100Hz – 16kHz +/- 3dB
      2) Sensitivity: 118 dB-SPL @ 1W, 1m (pink noise)
      3) Dispersion: Horizontal: 100 degrees; Vertical: 100 degrees
      4) Long term power handling: 150W continuous
      5) Impedance: 8 ohm nominal
      6) Color: BLACK
      7) Provide pan/tile brackets and connectors required to mount speakers VERTICAL in locations shown on the drawings to achieve a 30 degree pitch. Coordinate size of speakers in relation to mount locations with the architect.
   d. Indoor speaker model is EAW, JFX Series, Bose Room Match RMU208 or Reinkus Heinz.
   e. Provide three subwoofers, mounted where shown on the drawings (SPr2 symbol). Subwoofer shall be flown from ceiling. Bose model MB24 with U-bracket or suspended with threaded rod, or equal speakers by EAW or Reinkus Heinz. Subwoofer shall be BLACK.
   f. Provide two outdoor speakers: Panaray 802 Series III
5. Amplifiers
   a. Provide amplifiers sized as necessary to provide 85-90 dbSPL to the

audience area with even coverage based on specific speaker selection.
b. Mount all amplifiers in equipment rack .
c. Provide and install one Bose PM8500N for 4 room speakers.
d. Provide and install two Bose PM4250 for the subwoofers, one extra channel for the 5th inside speaker.
e. Provide one 4250 for the outdoor speakers.
e. Provide and install ESPlink cards required, ESP1240 processor, CC-64 Control Space unit and power supplies.
f. Amplifiers are by Bose, or equal by Crown (CTS4200 in quantities required for a channel per speaker for: five room speakers and 2 outdoor speakers; and three CTS3000, one for each subwoofer) or QSC (CMX300V for a channel per speakers (not subwoofer) driven, and three CMX2000V, one for each subwoofer.

6. Wireless microphone system (Qty 4 systems)
   a. Power On Indicator
   b. "RF" Diversity Signal Indicators
   c. Transmitted (TX) Audio Indicators
   d. Receiving Antenna Indicator
   e. Group/Channel Displays
   f. Transmitter Battery Life Indicator
   g. MODE Button for Menu Display
   h. SET Button for Saving Settings
   i. Mic/Line level Switch
   j. XLR and ¼" outputs with level control
   k. Provide rack mounting kit, and mount in equipment cabinet.
   l. Provide 1 handheld microphone, and one headworn microphone/transmitter combination on the same frequency for each system. Devices will not be used concurrently.
   m. Mount antennas where required for 100% room coverage. Provide all amplifiers, antennas, rigging and cabling required. Coordinate antenna placements with Architect.
   n. Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser.
7. Video Projector with Mount.
   a. Provide a minimum 14,000 ANSI lumens high-quality multimedia projector designed for a small to medium size presentation room with long throw lens sized to fit the full screens.
   b. Projector shall accept data, graphics and video inputs for use in front, rear and ceiling-mounted projection and screen sized from 31" to 300" diagonal.
   c. Projector shall features auto-setup functionality allowing fast plug & play set-up to RGB computer signals (VGA to WXGA) and use a digital visual interface (DVI) to offer picture-perfect digital connectivity to computer video cards, composite video, s-video and component video inputs.
   d. Projector shall have functions such as digital scaling; digital keystone and power zoom & focus to perfectly place a bright and crisp projected image.
   e. Specifications
      1) Min. native WUXGA resolution (1920 x 1200)
      2) Contrast Ratio 2500:1 (on/off)
      3) Digital and analog connectivity for data and video sources
      4) DTV and HDTV compatibility
      5) Pixel Clock 165MHz
      6) 3DLP
      7) Digital keystone correction and scaling
      8) Intuitive on-screen displays (OSD)

9) HDMI, DVI, VGA and Component inputs
10) Ethernet port and RS-232 port (provide LAN cable and connect to data port)

f. Provide and install at V1 location specified on drawings in floor one cafe
g. Projector shall provide sufficient horizontal and vertical lens shift to compensate for being off top of screen and askew of centerline without key stoning
h. Provide appropriate lens for distance of projector to screen to fully fit screen at 16:10 ratio.I
i. Video projector is WU14K-M by Christie or equal by Infocus or Mitsubishi.

8. Digital Receiver
   a. The receiver shall accept the HD signal via UTP/STP wire and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s).
   b. The receiver shall meet the following minimum requirements:
      1) Scaler
         a) HD video scaler, motion-adaptive deinterlacer, interlacer, intelligent frame rate conversion, Deep Color support, 3D to 2D conversion[2], content-adaptive noise reduction, widescreen format selection (zoom, stretch, maintain aspect-ratio, or 1:1), video wall processing (2x2, 3x2, 3x3, 4x3, or 4x4)[5]
         b) Input Resolutions Progressive
            i. 640x480@60Hz, 720x480@60Hz (480p), 720x576@50Hz (576p), 800x600@60Hz, 848x480@60Hz, 852x480@60Hz, 854x480@60Hz, 1024x768@60Hz, 1024x852@60Hz, 1024x1024@60Hz, 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1280x768@60Hz, 1280x800@60Hz, 1280x960@60Hz, 1280x1024@60Hz, 1360x768@60Hz, 1365x1024@60Hz, 1366x768@60Hz, 1400x1050@60Hz, 1440x900@60Hz, 1600x900@60Hz, 1600x1200@60Hz, 1680x1050@60Hz, 1920x1080@24Hz (1080p24), 1920x1080@25Hz (1080p25), 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60), 1920x1200@60Hz, plus any other resolution allowed by HDMI up to 165MHz pixel clock
         c) Input Resolutions Interlaced
            i. 720x480@30Hz (480i), 720x576@25Hz (576i), 1920x1080@25Hz (1080i25), 1920x1080@30Hz (1080i30), plus any other resolution allowed by HDMI up to 165MHz pixel clock
         d) Scaler Output Resolutions, Progressive
            i. 640x480@60Hz, 720x480@60Hz (480p), 720x576@50Hz (576p), 800x600@60Hz, 848x480@60Hz, 1024x768@60Hz[6], 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1280x768@60Hz, 1280x800@60Hz[6], 1280x960@60Hz, 1280x1024@60Hz, 1360x768@60Hz, 1366x768@60Hz[6], 1400x1050@60Hz[6], 1440x900@60Hz[6], 1600x900@60Hz[7], 1600x1200@60Hz, 1680x1050@60Hz[6], 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60), 1920x1200@60Hz[7]
         e) Scaler Output Resolutions, Interlaced
            i. 720x480@30Hz (480i), 720x576@25Hz (576i), 1920x1080@25Hz (1080i25), 1920x1080@30Hz

(1080i30)
f) Pass-Thru Output Resolutions
i. Matched to Input
2) HDMI digital video/audio output.
a) One (1) 19-pin Type A HDMI female connector.
3) One (1) USB 1.1 port for USB HID data.
a) Mouse, keyboard, game controller, or other USB HID device support.
b) USB Type A female connector.
4) One (1) bidirectional RS-232 port.
a) One (1) 5-pin 3.5mm detachable terminal block.
b) GND, TX, RX, CTS, RTS support.
c) Up to 115.2k baud, hardware and software handshaking support.
5) Two (2) IR/Serial ports.
a) One (1) 4-pin 3.5mm detachable terminal block.
b) IR output up to 1.1 MHz.
c) 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.
6) One (1) 10/100 LAN port.
7) One (1) STP input.
a) One (1) RJ-45 female connectors.
8) One (1) power input.
a) (1) 2.1mm barrel DC power jack.
9) Shall support transmission distances of up to 450ft.
10) Mountable to a 2-gang, 4" square, or Euro electrical box.

c. Digital Receivers shall be Crestron DM-RMC-SCALER-C or equal by Extron or Kramer. (Provide 3 for projector at ceiling, one for wall plate transmitter (PC input), one for rack mounted transmitter (of DVD player), one for rack mounted IPTV STB.

9. Provide and install two rack mounted digital transmitter for DVD and IPTV STB video to projector, DM-TX-201-C by Crestron or equal.
10. Integrated Room Control System
a. Provide a wireless touch panel based integrated control system with wireless gateway equipment (provide wireless access point and extended range RF transceiver equipment (CEN-ERFGW-POE) for RF and WiFi wireless touch panel functionality from any location in room). Provide wall dock charging station (TST-902-DSW and TST-902-DSW-BB) for touch panel to be mounted in the wall above the cabinet on first floor of room. Coordinate placement and conduit required to rack with electrical subcontractor. Electrical subcontractor to provide and install conduit required.
b. Provide PoE switch
c. Provide wireless access point to broadcast network stream in Cafe. Connect to PoE switch. Position WAP for 100% room coverage of the wireless touch panel. Coordinate antenna/wap location with architect.
d. 8.7” Wireless WiFi Touch Panel
1) Features
a) 8.7” TFT active matrix touch color LCD
b) 1008 x 588 pixels
c) 24-bit 16.7M color depth
d) Communications: 802.11a/b/g Wi-Fi 2-way and 2-way RF 2.4GHz ISM Channels 11-26 for wireless communications
e) Onboard PC applications for Web browsing and streaming media
f) Shall present video from teleconferencing cameras wirelessly, and shall allow PTZ control of teleconferencing cameras wirelessly
g) Internal Li-Ion battery pack included

h) Brightness: 300 nits
i) Contrast: 700:1
j) Video H.264 or MJPEG, up to 1280x720 @30 fps

e. 8.7" Wireless Touch Panel is Crestron TST-902 or equal by AMX or Extron
f. System shall control the following devices:
1) DVD, Power and Transport
2) CD/iPod Unit, Power and Transport Controls
3) Projector power and selection controls
4) Projection Screens (front and rear projection screens) (Up/Down)
5) Audio volume control
6) Speaker selections (indoor or outdoor or both)
7) IPTV STB
8) AM/FM tuner
9) Aux input
g. Communications subcontractor shall design a graphical user interface to control and switch all devices above. Owner must approve screen design prior to system programming.
h. Touch panel shall be integrated with fire alarm control panel. Upon fire alarm activation, touch panel shall flash the word FIRE in red on the screen and all audio sources shall be muted. Electrical subcontractor shall provide source, communications subcontractor of this section shall install override and test. All audio programming shall be muted upon PA announcement. 275000 communications subcontractor shall provide source, communications subcontractor of this section shall install override and test
i. Provide controller that is Ethernet capable for touch panel. Provide all power supplies and related equipment for a fully functional system in accordance with design intent. Crestron Pro 3 or equal by AMX or Extron.
j. Provide wireless touch panel dock and install in rack .

11. AM/FM Tuner Unit
a. AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
b. AM/FM Tuner shall have a 30 station random present memory.
c. AM/FM Tuner shall support radio data system functions included in carrier signals.
d. Display screen shall display AM/FM program service name, and current time.
e. Unit shall be rack mounted.
f. AM/FM Tuner is PT504 by Pyle Pro or equal by Denon, Tascam or Marantz.

12. Assistive Listening System
a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
b. The transmitter shall have a SNR of 80dB or greater.
c. The output power shall be adjustable to quarter, half or full.
d. Channel tuning shall be capable of being locked.
e. The device shall broadcast on both wide and narrow band channels.
f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
h. Provide appropriate antenna, and rack mounting kit. Provide all rigging, amplifiers, cables, and equipment to mount antennas to the back wall at the projector location. Ensure full room coverage. Coordinate antenna placements with Architect.

i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and five transformer/wall chargers.
j. System is the Listen LT-800, Phonic Ear, Williams Sound or equal.

13. Equipment Rack
    a. Provide 19" Equipment Rack, ERK-4425 with side panels, lockable rear door and screened lockable front door installed in closet designated on drawings. Mount all audio mixing, source, and speaker equipment in rack. Size rack to fit all equipment provided based on vendors actual equipment selection. Provide a storage drawer in rack for microphones and cabling.
        1) Provide rack faceplate with 3.5mm aux input to DSP
14. Cabling – Provide and Install:
    a. Provide for a complete and operational system, similar to classroom connectivity, to include all cables required for desired form and function stated above.
    b. Provide HDMI cabling to connect receiver output to projector at ceiling.
    c. Provide all cat6 patch cords for projectors to be connected to purple data outlets, of appropriate color.
    d. Provide 25' HDMI cable for presenter use. Store in drawer of rack.
    e. Provide 25' VGA cable with 3.5mm audio. Store in drawer of rack.
    f. Any other cabling required for a complete and operational system. See T2.9.
15. Wall Mounted Digital Transmitters (Provide 1 at V2.)
    a. The transmitter shall meet the following minimum requirements:
        1) One (1) HDMI input
        2) One(1) RGB input
        3) One (1) analog 3.5mm stereo audio input.
        4) One (1) USB HID port.
           Supports USB 1.1.
        5) One UTP/STP HDMI extended signal output RJ-45 Female.
           Signal transmission on CAT5e or better.
        6) One (1) power input.
    b. Wall mountable on US 2-gang electrical box.
    c. Wall Mounted Digital Transmitter is Crestron DM-TX-200-C-2G or equal by Extron or Kramer. Provide DM-RMC-200-C 8G+ Receiver at projector. Connect receiver audio to DSP, and receiver video to projector.
16. Microphones, Stands, Cords
    a. Provide:
        1) 4 microphones of type Peavey PVM46 or equal by Shure or Crown.
            a) Diamond-coated diaphragm
            b) Neodymium iron boron magnet
            c) Hyper-cardioid polar pattern
            d) 15 dB (typical) front to back rejection
            e) 400 ohms, balanced
            f) 45 Hz - 16 kHz frequency response
            g) Ultra-high sensitivity (-51 dB)
            h) 140 dB maximum SPL
            i) Black rubberized paint finish
            j) Swivel adapter
            k) Protective pouch
        2) 4 microphone stands
        3) 4 microphone cords, 25'
17. IPTV Set Top Box (STB)
    a. IPTV STB (provided by 27 70 00). Locate in EQ Sound rack. Provide and install HDMI video to transmitter, and audio to DSP audio system input. Touch panel control system shall include icon and programming to present

IPTV on projector screen and over the sound system. STB output shall be viewable on the room projector.

18. Provide and install IR receiver and emitter for the projector. Install IR receiver at IP symbol location in the Café, route emitter to projector via pole mount and blank ports on V1. Test and verify performance.

2.3 Café (Floor 3)

A. General:

1. Floor 2 Café shall be equipped with a local sound reinforcement system with distributed program speakers and subwoofers. Speakers shall be mounted in permanent locations as shown on the drawings.
2. Digital signal processors (DSPs) and audio program equipment shall be installed within a 19" full rack to be installed in the specified location.
3. Provide and install for audio muting upon PA announcement and upon fire alarm activation.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to power-up, select, and control audio source materials
   b. Ability to distribute audio programming from CD/iPod combination, microphones, and building PA system.

C. Products:

1. 8 channel DSP Mixer with AEC at mic / line inputs
   a. The mixer shall have eight mixer input ports.
   b. 3 Standard balanced mic / line inputs
   c. 4 balanced mic / line outputs.
   d. Provide a rack mount bracket.
   e. Unit must be equipped to mute current audio program if building PA system is activated. PA system communications subcontractor to provide program source.
   f. Telephone interface required.
   g. Serial port for third party RS232 Control
   h. DSP is Nexia TC and Nexia VC in quantities needed for design intent, or equal by Clearone or QSC.
2. CD iPod Dock Combination Unit
   q. Plays audio CDs, MP3 CDs and WAV file CDs
   r. Provide output terminals for both RCA and XLR connections
   s. Dock connector for Apple iPod charging and playback
   t. iPod video playback from S-video or composite output
   u. CD TEXT and ID3 tag support
   v. Continue, Random and Program play modes
   w. Repeat All and Repeat Single play modes
   x. Index Search
   y. Shock/skip prevention memory buffer
   z. ±12% pitch control (analog outputs only)
   aa. RCA unbalanced line outputs (CD and iPod)
   bb. Coaxial and Optical S/PDIF digital out (CD only)
   cc. 1/4" stereo headphone output
   dd. 2u rack mountable
   ee. Wireless 55-key remote control
   ff. 19"W x 3.72" H x 11.73"D

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz.
3. Speakers Qty 5 and 3 Subwoofer
   a. Mount speakers as shown on the drawings, flown from the ceiling.
   c. Speaker parameters:

1) Frequency response: 100Hz – 16kHz +/- 3dB
2) Sensitivity: 118 dB-SPL @ 1W, 1m (pink noise)
3) Dispersion: Horizontal: 100 degrees; Vertical: 100 degrees
4) Long term power handling: 150W continuous
5) Impedance: 8 ohm nominal
6) Color: BLACK
7) Provide pan/tile brackets and connectors required to mount speakers VERTICAL in locations shown on the drawings to achieve a 30 degree pitch. Coordinate size of speakers in relation to mount locations with the architect.

d. Speaker model is EAW, JFX Series, Bose Room Match RMU208 or Reinkus Heinz. Subwoofer: MB24
e. Provide three subwoofers, mounted where shown on the drawings (SPr2 symbol). Subwoofer shall be flown from ceiling. Bose model MB24 with U-bracket or suspended with threaded rod, or equal speakers by EAW or Reinkus Heinz. Subwoofers shall be BLACK.

4. Amplifiers
   a. Provide amplifiers sized as necessary to provide 85-90 dbSPL to the audience area with even coverage based on specific speaker selection.
   b. Mount all amplifiers in equipment rack .
   c. Provide and install one Bose PM8500N for the 4 room speakers.
   d. Provide and install two Bose PM4250 for the subwoofers, one extra channel for the 5th room speaker
   e. Provide and install ESPlink cards required, ESP1240 processor, CC-64 Control Space unit and power supplies.
   f. Amplifiers are by Bose, or equal by Crown (CTS4200 in quantities required for a channel per speaker for: five room speakers and three CTS3000, one for each subwoofer) or QSC (CMX300V for a channel per speakers (not subwoofer) driven, and three CMX2000V, one for each subwoofer.
5. Wireless microphone system (Qty 4 systems)
   a. Power On Indicator
   b. “RF” Diversity Signal Indicators
   c. Transmitted (TX) Audio Indicators
   d. Receiving Antenna Indicator
   e. Group/Channel Displays
   f. Transmitter Battery Life Indicator
   g. MODE Button for Menu Display
   h. SET Button for Saving Settings
   i. Mic/Line level Switch
   j. XLR and ¼” outputs with level control
   k. Provide rack mounting kit, and mount in equipment cabinet.
   l. Provide 1 handheld microphone, and one headworn microphone/transmitter combination on the same frequency for each system. Devices will not be used concurrently.
   m. Mount antennas where required for 100% room coverage. Provide all amplifiers, antennas, rigging and cabling required. Coordinate antenna placements with Architect.
   n. Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser.
6. AM/FM Tuner Unit
   a. AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
   b. AM/FM Tuner shall have a 30 station random present memory.
   c. AM/FM Tuner shall support radio data system functions included in carrier

signals.
d. Display screen shall display AM/FM program service name, and current time.
e. Unit shall be rack mounted.
f. AM/FM Tuner is PT504 by Pyle Pro or equal by Denon, Tascam or Marantz.

7. Assistive Listening System
   a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
   b. The transmitter shall have a SNR of 80dB or greater.
   c. The output power shall be adjustable to quarter, half or full.
   d. Channel tuning shall be capable of being locked.
   e. The device shall broadcast on both wide and narrow band channels.
   f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
   g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
   h. Provide appropriate antenna, and rack mounting kit. Provide all rigging, amplifiers, cables, and equipment to mount antennas to the back wall at the projector location. Ensure full room coverage. Coordinate antenna placements with Architect.
   i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and five transformer/wall chargers.
   j. System is the Listen LT-800, Phonic Ear, Williams Sound or equal.
8. Equipment Rack
   a. Provide 19" Equipment Rack, with side panels, and lockable front door installed in closet designated on drawings. Mount all audio mixing, source, and speaker equipment in rack. Size rack to fit all equipment provided based on vendors actual equipment selection. Provide a storage drawer in rack for microphones and cabling.
      1) Provide 3.5mm aux input to DSP on rack faceplate
      2) Provide rack mounted control panel and all accessories required to integrate to system to provide the following functions:
         a) System Power On/Off
         b) Source selection
         c) Volume control

9. Cabling – Provide and Install:
   a. Provide for a complete and operational system to include all cables required for desired form and function stated above.
16. Microphones, Stands, Cords
   a. Provide:
      1) 4 microphones of type Peavey PVM46 or equal by Shure or Crown.
         a) Diamond-coated diaphragm
         b) Neodymium iron boron magnet
         c) Hyper-cardioid polar pattern
         d) 15 dB (typical) front to back rejection
         e) 400 ohms, balanced
         f) 45 Hz - 16 kHz frequency response
         g) Ultra-high sensitivity (-51 dB)
         h) 140 dB maximum SPL
         i) Black rubberized paint finish
         j) Swivel adapter
         k) Protective pouch

2) 4 microphone stands
3) 4 microphone cords, 25’

2.4 Gymnasium

A. General:

1. Gymnasium shall be equipped with a local sound reinforcement system with the ability to separate program distribution to a full gym configuration, two one half-gymnasium configuration, and one-half with separation of remaining one-quarter and one-quarter into two distinct program areas, divided by the room division screens.
2. Room separation control shall be via DSP located in rack in sound closet location as designated on the drawings.
3. Speakers shall be mounted in permanent locations on the trusses. Speakers shall not be mounted where damage may occur.
4. Provide adequate speaker coverage for floor and track areas. Coverage area shall provide a clear signal to bleacher area and gymnasium floor.
5. 8 Channel Sound mixing console and audio program equipment shall be installed within a 19” full size rack.
6. Wireless touch panel control system.
7. Crowd noise in a high school gymnasium can easily reach 90 dBA or more during the course of a sporting event. Installers shall plan for a minimum signal/noise (10 dB) and plan for an amplifier/speaker combination that should be capable of continuous operation at 100 dBA in audience areas.
8. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment including all wall plates.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to distribute program and live audio sources to the gym as defined in A.1 above.
   b. Ability to use wireless touch panel from anywhere in the gym to control audio sources and sound partitions.
2. System must provide intelligible sound to the audience despite a great deal of crowd noise.
3. Ability to present audio from the V4 plate with a source from a portable cart.

C. Products:

1. Digital Signal Processors (Minimum 1, provide in quantities for required for design intent)
   a. Provides a fixed configuration of 12 inputs (min) and 8 outputs (min), configurable signal processing and a high bandwidth, fault tolerant digital audio bus.
   b. Open architecture which is fully configurable through HiQnet™ London Architect. A rich palette of processing and logic objects and a “drag and drop” method of configuration provide a simple and familiar design environment.
   c. The processor features a low latency, fault tolerant digital audio bus of 48 channels which uses standard Category 5e cabling giving a distance of 100m between compatible devices. Fiber media converters can be used to increase the distance between devices to over 40km.
   d. Analog Inputs provide software configurable gain in 6dB steps up to +48dB per channel and software selectable Phantom Power per channel.
   e. Phantom Power, Signal Present and Clip information per channel is easily accessible, without the requirement for a PC, from clear front panel LED indication. A bi-directional locate function allows devices to be identified both

from and within HiQnet London Architect.

f. 12 Control Inputs and 6 Logic Outputs integrate with GPIO compatible devices.

g. Key Features:
   1) 12 Analog Inputs (min) (with 48v Phantom Power per Channel)
   2) 8 Analog Outputs (min)
   3) Configurable Signal Processing
   4) Rich Palette of Processing and Logic Objects
   5) 48 Channel, Low Latency, Fault Tolerant Digital Audio Bus
   6) Clear Front Panel LED Indication
   7) Bi-Directional Locate Functionality
   8) 12 Control Inputs and 6 Logic Outputs for GPIO integration
   9) Technical Specifications:
      a) Front Panel Led Indicators:
         i. Per Input: Signal Present, CLIP, 48V (Input only)
         ii. Other: COM, STAT, ERR, PWR
      b) Analog Inputs: 12 electronically balanced on Phoenix Combicon removable screw connectors
         i. Mic/Line Inputs:
            a. Nominal gain 0dB, electronically switchable up to +48dB,in +6dB steps
         ii. Input Impedance:
            a. *3.5k*Ω
         iii. Maximum Input Level:
            a. *+20dBu with 0dB input gain,+8dBu with 12dB gain*
         iv. CMRR:
            a. *>75dB at 1KHz*
         v. Input Noise (E.I.N.):
            a. *<-128dBu typical with 150Ω source*
         vi. Phantom Power:
            a. *48V nominal, selectable per input*
         vii. A/D Latency:
            a. *37/Fs [0.77ms@48k]*
      c) Analog Outputs: 8 (min) electronically balanced on Phoenix/Combicon removable screw connectors
         i. Maximum Output Level:
            a. +19dBu
         ii. Frequency Response:
         iii. 20Hz-20KHz (+0.5dB/-1dB)
         iv. THD:
            a. <0.01% 20Hz to 20KHz, +10dBu output
         v. Dynamic Range:
            a. 108dB typical, 22Hz-22KHz unweighted
         vi. Crosstalk:
            a. <-75dB
         vii. Output Impedance:
            a. 40Ω balanced and 20 Ω unbalanced
         viii. D/A Latency:
            a. 29/Fs [0.60ms@48k]
      d) Control Ports: 12 inputs and 6 outputs
         i. Control Input Voltage:
            a. 0 to 4.5v
         ii. Control Input Impedance:
            a. 4.7kÙ to +5V (2-wire mode), >1MÙ (3-wire mode)

iii. Logic Output Voltage:
a. 0 or +5V unloaded
iv. Logic Output Impedance:
a. 440 Ω
v. Logic Output Current:
a. 10mA source, 60mA sink

e) Watchdog Output: Phoenix/Combicon connector for failsafe control
i. Opto Output Current:
a. 14mA maximum
ii. Withstanding Voltage:
a. 80V maximum (Off)
iii. Series Impedance:
a. 220 Ω (isolated)

f) Control Network:
i. Connectors:
a. RJ45 Ethernet connector
ii. Maximum Cable Length:
a. 100m/300ft on Category 5 cable between device and Ethernet switch

g) BLU Link:
i. Connectors:
a. 2 x RJ45 Ethernet connectors
ii. Maximum Cable Length:
a. 100m/300ft on Category 5e cable between devices
iii. Max. Number of Nodes:
a. 60
iv. Latency:
a. 11/Fs [0.23ms@48k]
v. Pass Through Latency:
a. 4/Fs [0.08ms@48k]

h) Power and Dimensions:
i. Mains Voltage:
a. 100-240V AC, 50/60Hz
ii. Power Consumption:
a. <55VA
iii. BTU Rating:
a. <188 BTU/hr
iv. Operating Temp. Range:
a. 5 (41) to 35 (95) degrees C (degrees F)
v. Dims:
a. (H(U) x W x D): 1.75" (1U) x 19" x 9.0" (45mm x 483mm x 229mm)
vi. Weight:
a. 6.4 lbs / 2.9 Kgs

Digital Signal Processor shall be the BSS Audio BLU-100 and BLU-BOB2 and/or BLU-BIB as necessary or equal by Biamp Audia Flex or Soundweb.

2. Carousel-type 5 CD Changer and AM/FM Tuner Combination Unit
a. The 5 CD Changer + AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
b. Provide three modes of CD playback. All disc random play, disc sequential random play, or program random play.
c. CD can play a single selection, or continuous play.
d. AM/FM Tuner shall have a 30 station random present memory.

e. AM/FM Tuner shall support radio data system functions included in carrier signals.
f. Display screen shall display AM/FM program service name, and current time.
g. Unit shall be rack mounted and RS-232 controllable
h. This item may be submitted as two units if rack space allows, provided they meet the above specification

5 CD Changer- AM/FM Tuner Combination Unit manufacturer is Denon or equal by Tascam or Marantz, or separate units: 5-CD changer PMD-371 by Denon or equal; AM/FM tuner PT504 by Pyle Pro or equal.

3. Wireless Microphone Systems - Provide five (5)
   a. Power On Indicator
   b. "RF" Diversity Signal Indicators
   c. Transmitted (TX) Audio Indicators
   d. Receiving Antenna Indicator
   e. Group/Channel Displays
   f. Transmitter Battery Life Indicator
   g. MODE Button for Menu Display
   h. SET Button for Saving Settings
   i. Mic/Line level Switch
   j. XLR and ¼" outputs with level control
   k. Provide rack mounting kit, and mount in equipment cabinet.
   l. Provide 1 handheld microphone, and one headworn microphone/transmitter combination on the same frequency. Devices will not be used concurrently.
   m. Provide 2 distributed antennas (min) and a combiner for the 5 systems
   n. Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Sennheiser or Electro-Voice.
4. CD iPod Dock Combination Unit - Provide Qty 2
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4" stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19"W x 3.72" H x 11.73"D

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz

~~5. Microprocessor controlled Matrix Switcher- 8 inputs x 8 outputs~~
   ~~a. Provide a broadcast quality matrix/routing switcher capable of switching multiple audio sources. Provide for 8 input sources and 8 output sources.~~
   ~~b. System shall be capable of being expanded by adding modules and flashing firmware. System shall not require to be sent back to factory to update.~~
   ~~c. Balanced and unbalanced stereo audio.~~
   ~~d. Adjustable input gain/attenuation (adjustable via RS-232/422). Allow for settings between –15dB to +9dB.~~
   ~~e. Complete audio breakaway will allow for separate audio signals from the video signal to switch either video only, or audio only. Allows for audio follow~~

~~on one or all channels.~~

~~f. Unit must support full control via RS-232/422 for connection into integrated touch panel control system.~~

~~g. Unit shall be rack mountable in a 19" equipment rack, 2U.~~

~~h. Inputs to the matrix switcher shall be from:~~

~~1) All Microphone Jacks (including V4 mic)~~

~~2) Two Combination CD/iPod Players~~

~~3) 5 CD/AM & FM Combination Unit (or both separate units)~~

~~4) Left & Right RCA Input, Rack mounted.~~

~~5) V4 audio input~~

~~6) R2 input from TV Studio (provide and install cable)~~

~~i. Outputs from the matrix switcher shall be to:~~

~~1) Amplifiers for Speakers~~

~~2) Assistive listen system~~

~~3) Line level audio output to R2 for TV Studio (provide and install cable)~~

~~j. Microprocessor controlled matrix switcher is Extron model 60-658AX in quantities required for design intent or equal by Crestron or Kramer.~~

6. Assistive Listening System
   a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
   b. The transmitter shall have a SNR of 80dB or greater.
   c. The output power shall be adjustable to quarter, half or full.
   d. Channel tuning shall be capable of being locked.
   e. The device shall broadcast on both wide and narrow band channels.
   f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
   g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
   h. Provide two antennas, distribution and combiner equipment, placed in the gym space for 100% gym coverage.
   i. ~~Provide 113 programmable receivers (Listen Technologies LR-500 or equal) with 73 earbuds, 40 LA-166 Neck Loop lanyards, and rechargeable batteries, and 113 transformer/wall chargers.~~ **Provide 5 programmable receivers, (Listen Technologies LR-500 or equal) with 5 ear buds and 5 LA-166 neck loop lanyards, rechargeable batteries, and 5 transformer/wall chargers.**
   j. Listen LT-800, with rack mount kit, Phonic Ear, Williams Sound or equal.
7. Amplifiers
   a. Provide amplifiers sized as necessary to provide 95-100 dbSPL to the audience area with even coverage based on specific speaker selection.
   b. Mount all amplifiers in equipment rack in sound control closet.
   c. Provide separate amplifiers for design intent.
      1) For Speakers ½ by ½, ¼ by ¼ by ½ and full gym
   d. ~~Amplifiers are by Bose, Crown International, CT Series, Crest or Hafler~~ **Amplifiers are by Bose,(PM8500 (in quantities required for separation and one channel per speaker) with PM ESPlink cards, CC-64 control space unit with CC-PS1, ESP1240 sound processor with ESPlink card) by Crown (CT8150 in quantities required for separation and a channel per speaker (excluding subwoofers) and CTS1200 in quantities required for separation and for a channel per subwoofer) or QSC (CMX300V in quantities required for separation and a channel per speaker (excluding subwoofers) and CMX2000V in quantities required for separation and for a channel per subwoofer.**

8. Speakers
   a. Speakers shall be affixed to gymnasium trusses.
   b. Provide a distributed speaker system as shown on the drawings (SPr locations). Speakers shall be installed facing down to provide coverage to the floor.
   c. Provide 3 Subwoofers where shown on the drawings (SPr2).
   d. Distributed speakers are EAW KF Series Loudspeakers, Bose Panaray 402 series or equal by Reinkus Heinz.
   e. Subwoofers are Bose LT MB24 series 3 or equal by EAW or Reinkus Heinz
   f. All speakers shall be white.
9. Integrated Room Control System
   a. Provide a wireless touch panel based integrated control system with wireless gateway equipment (provide wireless access point (total 4) and extended range RF transceiver equipment (CEN-ERFGW-POE, provide 2 evenly spaced atop trusses) for RF and WiFi wireless touch panel functionality from any location in room). Provide wall dock charging station (TST-902-DSW and TST-902-DSW-BB) for touch panel to be mounted in the rack.
   b. Provide PoE switch
   c. Provide wireless access points to broadcast network stream in room. Connect to PoE switch. Position WAPs for 100% room coverage of the wireless touch panel spaced evenly in the gym, above the trusses. Coordinate antenna/wap location with architect.
   d. 8.7" Wireless WiFi Touch Panel
      1) Features
         a) 8.7" TFT active matrix touch color LCD
         b) 1008 x 588 pixels
         c) 24-bit 16.7M color depth
         d) Communications: 802.11a/b/g Wi-Fi 2-way and 2-way RF 2.4GHz ISM Channels 11-26 for wireless communications
         e) Onboard PC applications for Web browsing and streaming media
         ~~f) Shall present video from teleconferencing cameras wirelessly, and shall allow PTZ control of teleconferencing cameras wirelessly~~
         g) Internal Li-Ion battery pack included
         h) Brightness: 300 nits
         i) Contrast: 700:1
         j) Video H.264 or MJPEG, up to 1280x720 @30 fps
   e. 8.7" Wireless Touch Panel is Crestron TST-902 or equal by AMX or Extron
   f. System shall control the following devices:
      1) 5 CD changer, Power and Transport
      2) Both CD/iPod units, Power and Transport
      3) DSP Audio switcher
      4) Speaker selections: 1/4x1/4x1/2; 1/2x1/2; full gym
      5) AM/FM Tuner
   g. Communications subcontractor shall design a graphical user interface to control and switch all devices above. Owner must approve screen design prior to system programming.
   h. System and touch panel shall be integrated with fire alarm control panel. Upon fire alarm activation, touch panel shall flash the word FIRE in red on the screen and all audio sources shall be muted. Electrical subcontractor shall provide source, communications subcontractor of this section shall install override and test. All audio programming shall be muted upon PA announcement. 275000 communications subcontractor shall provide source, communications subcontractor of this section shall install override and test
   i. Provide controller that is Ethernet capable for touch panel. Provide all power

supplies, cabling and related equipment for a fully functional system in accordance with design intent. Crestron Pro ~~2 with C2ENET-2 card~~ **3** or equal by AMX or Extron.

j. Provide wireless touch panel dock and back box and install in rack.

10. Equipment Rack
    a. Provide 1 (One) 44 Space metal equipment rack (Middle Atlantic ERK 4425 with side panels, rear locking door and screened front lockable door or equal by Sanus or Peerless) at sound closet location in 1044. Provide rack mounted power strips as necessary to power rack equipment. Provide L&R RCA audio input jacks on a rack mounted plate. Connect to audio input of the system.
11. Microphones, Stands, Cords
    a. Provide:
        1) Six (6) microphones of type Peavey PVM46 or equal by Shure or Crown
            a) Diamond-coated diaphragm
            b) Neodymium iron boron magnet
            c) Hyper-cardioid polar pattern
            d) 15 dB (typical) front to back rejection
            e) 400 ohms, balanced
            f) 45 Hz - 16 kHz frequency response
            g) Ultra-high sensitivity (-51 dB)
            h) 140 dB maximum SPL
            i) Black rubberized paint finish
            j) Swivel adapter
            k) Protective pouch
        2) 6 microphone stands
        3) 6 microphone cords, 25’
        4) 2 Microphone cords, 50’
        5) 2 microphone deskstands with mounting adapter

2.5 Video Wall System

A. General

1. It is the intent of these specifications and drawings to include everything required for proper and complete installation and operation of the video wall, Control and Audio Systems, even though every item may not be specifically mentioned.
2. The Communications Subcontractor shall provide all items necessary for a complete, safe, fully functional system as described herein, including all tools, scaffolding, labor, and supervision, even though they may not be specifically enumerated. Any errors, omissions or ambiguities do not relieve the Communications Subcontractor of this responsibility, but must be included in the price and brought to the attention of the Architect for clarification.
3. Furnish and install all low voltage wire and cable required for video wall and audio system installation.

B. Control System Description

1. The system shall use and interface with Microsoft Windows 7 operating system.
2. The system shall be capable of receiving multiple inputs from different types of media and displaying them onto the Video wall. Input from each device connected to the system shall be capable of being displayed inside of layout windows using the video wall control software. Video content shall be able to be placed anywhere on the video wall and multiple windows can be open and operate simultaneously.
3. The system shall be capable of “plug-and play” input video signal detection.
4. The system shall have “Real-time” customization and arrangement of content.

5. Widow appearance shall be customizable.
6. There shall be a feature to save layouts and video wall configuration settings to an easily recallable preset. A minimum of 18 preset layouts are required.
7. The system shall be capable of Remote access by a minimum of 1 simultaneous remote user to control the video wall using any Windows based PC on the Network.
8. The system shall be fully compatible with RS-232 serial control.
9. The system shall output a high fidelity Stereo signal to the audio system for playback from any one of the selected content inputs.

F. System Specific Inputs and Outputs:
   1. The system shall be capable of receiving inputs from:
      a. A minimum of two (2) IPTV inputs from the Owners Network system. IPTV Set Top Boxes provided by 27 70 00.
      b. BluRay/DVD player.
      c. One RJ45 connectors for Network/Internet.
      d. One input from an adjacent computer (provided and installed by communications subcontractor of this section).
   2. The system shall be capable of outputting DVI signals to six (6) NEC X461UN Monitors in a 2 x 3 wall configuration.

G. Furnish and Install, where specified and shown on the drawings, the following equipment. All equal items submitted must be of equal quality, form and function to be considered:

Quantity	Model #	Display Equipment
6	NEC X461UN	NEC 46” Ultra Narrow Bezel LCD Panel
6	NEC KT-46UN-OF	X46UN OverFrame Bezel Kit
6	LSMVU	Chief – Wall Mount for Video Wall Tiling
1	NEC KT-46UN-CC	Color Calibration Kit
		Video Equipment
2	60-600-02	Extron – MLC-226 IP controller
2	60-483-20	Extron – SW-12A Audio Switcher
2	DIN-L1	Jensen Isolation transformer
4	26-614-02	6’ – HDMI-DVI Cable
6	26-584-01	DVI – M-M cable, length as required for installation
		Control Equipment
2	WC5000	ICS Video Wall control system with 9 RGB/DVI outputs, 4 RGB PC/DVI/HD component, 4 HDMI inputs, Wall Controller Software, ICS wall panel control software.
1	AP5017	1U rackmountable 17” LCD Monitor with integrated keyboard and mouse with KVM switch for 2 computers.
8	Generic	RS-232 Cables sized to reach all displays as shown in drawing.
1	SS	Heavy duty sliding shelf
Lot	As Required	Cables/Connectors/Hardware
		Rack & Miscellaneous
1	SR-40-22	Middle Atlantic 35 Space Equipment Rack. 22” Deep.
1	PD915R	Middle Atlantic Rack Mounted Power Strip
1	RR35	Middle Atlantic Rear Rack Rails
1	UPS – 1500	Rack mount 1500 watt output Battery back-up UPS

		Content / Inputs
1	DNV-500BD	Denon Rack mount DVD /BluRay player
1	FAN with GUARD	Mount in top of rack (4.5" fans), to exhaust heat from rack
2	MM1272	ETR – IPTV Decoder (Supplied by 27 70 00 subcontractor)
1	CD-200i	Tascam CD/Ipod Player
		Labor
1		Design and Engineering
1		Control Programming
1		Installation

Audio System

1	Furman	PL-PRO-C	20 amp surge suppressor outlet
1	DBX	260	Drive Rack
1	QSC	CX-902	Power Amplifier
2	JBL	Control AV29-1	Two-way Loudspeaker with mounting hardware
1	Listen	LS-03-216	Complete Hearing Assist system with antenna
1	Mid. Atlantic	D3	Two space drawer for storage
Lot	Wire	Various	All wire shall be West Penn or Belden, no equal
Lot	Wall Plates	Custom	Custom as required per drawings
Lot	Mid. Atlantic	Various	Blank plates as required to fill racks
1	PC, Windows	Rack Mounted	With current Microsoft Office installed

2.6 Audio Visual Cabling

A. General:

1. The following types of signal cables shall be used on this project:
   a. #24 AWG Audio Microphone Cable
   b. Special intercom cabling- balanced and shielded, 3 pair.
   c. Audio Wire / Speaker Cabling #14 AWG for Speakers
   d. Analog Multi-Pair Snake Cable- 4, 8 & 12 Pair
   e. RGB Bundled Cable - 3 & 5 Conductor
   f. Precision analog/digital video cable- RG/59/U Video Snake Cable
   g. 4-Pair Cat 6 for equipment controls and video transmission – Gray
   h. Every interactive and ceiling projector in classrooms requires two (2) HMDI cables.
2. TERMINATION HARDWARE: The following types of connectors shall be used on this project
   a. XLR Connectors- 3 Position (microphones) and 6 Position (intercom on V8) Neutrick or equal
   b. Category 6 Data/Voice Jacks, (must be Gray) Panduit Mini-Com series, Siemon, or equal
   c. F Type Connector
   d. RCA Connectors
   e. VGA connectors
   g. USB connectors (if required)
   h. HDMI connectors and passthru keystone connectors

B. Category 6 Cable 4-Pairs- Equipment Controls

1. The Category 6 cable shall use the color code indicated below:
   a. All Category 6 cable for Equipment Control shall be Gray.
   b. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of 24-gauge bare solid copper conductors bonded

pairs, ripcord. Cable shall be insulated with a marked (every 2 ft) polyethylene vinyl chloride jacket. There shall be no shield required in the sheath.

3. Each sheath shall contain 4 unshielded copper twisted pairs. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.
4. The cables shall meet or exceed the following standards:
   a. ANSI/TIA/EIA-568-B.2-1 “Commercial Building Telecommunications Cabling Standard” Horizontal Cabling Section.
   b. IEEE 802.3
   c. ICEA 580-576.
   d. Canadian Standards Association IWC FT4.
   e. National Electric Code - Article 800.
   f. Proposed ANSI X3T9.S requirements for UTP at 100 Mbps and 155 Mbs ATM.
   g. Cable manufacturer must be ISO-9002 Certified.
   h. Cable Color:
      1) Equipment Control — Gray.
   i. Patch Cable Color
      1) Equipment Control — gray.
   j. Maximum operating voltage- 300V RMS
   k. Nom. Capacitance @1 kHz- 15 pF/ft
   l. Nom. Velocity of Propagation- 70%
5. In addition to complying with the above listed standards, all Category 6 cables shall meet or exceed the following criteria:
   a. Testing shall be in accordance with procedures in the referenced standards unless otherwise stated.
   b. All cables shall meet, as a minimum, the requirements of:
      1) CSA
      2) NEC
      3) UL444
      4) ANSI/TIA/EIA-568-B Category 6
      5) ISO/IEC 11801 Category 6
   c. Factory splices of the insulated wire are not allowed in any portion of the cable, Butt-welded conductors prior to insulating are permitted.

C. 24 AWG Audio Microphone Cable
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a 2 #24 AWG tinned copper conductors, and a PVC Exterior jacket.
3. Cable shall contain a tinned copper braid shield, and have a rubber insulation jacket.
4. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory
   b. National Electric Code
   c. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Temperature Rating - -30 to + 60 deg C
   b. Continuous current per conductor - 5.2 Amps
   c. Structural Return Loss- 5-1000MHZ, 20DB Min
   d. Maximum Operating Voltage - 350v RMS
   e. Normal Conductor DC Resistance @ 20deg C - 6.8 Ohms / 1000’
   f. Normal Shield DC Resistance @ 20deg C - 2.7 Ohms / 1000’
   g. Normal impedance - 50 Ohms
   h. Normal inductance - .19 Micro H/ Ft
6. The cable is Belden Wire and Cable, #1503 or equal

D. Special Intercom Cabling- 3 Pair #18 AWG
   1. The cable shall be gray. Colored tape may not be used to re-identify jacket color.
   2. The cable shall be composed of 3 pairs (6 conductor) #22 AWG copper conductors, and a flex plenum PVC insulation jacket.
   3. Each pair individually 100% aluminum polyester foil shield.
   4. The cables shall meet or exceed the following standards:
      a. Underwriters Laboratory- 1581 Flame Resistance
      b. National Electric Code article 800
      c. UL Type CM
      d. NFPA 262 Flame Test
      e. Cable manufacturer must be ISO-9002 Certified
   5. Cable shall meet the following performance specifications:
      a. Temperature Rating- -10 to +60 deg C
      b. Maximum Operating Voltage- 300v RMS
      c. Max capacitance between conductors @ 1KHZ- 68 PF/FT Nom.
      d. Capacitance between conductor to shield- 122 PF/FT Nom.
      e. DC Resistance per conductor @ 20deg C- 6.2 Ohms / 1000' Nom.
   6. Pair Color:
      a. Pair One- Black/Red
      b. Pair Two- White/Green
   7. The cable is West Penn 25441B or equal.

E. Audio Wire / Speaker Cabling #14 AWG
   1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
   2. The cable shall be composed of a 4 #14 AWG stranded (104x34) bare copper conductors with anti-corrosion treatment.
   3. Cable shall have a poly vinyl chloride insulation, unshielded, and a polyvinyl chloride jacket.
   4. The cables shall meet or exceed the following standards:
      a. Underwriters Laboratory
      b. National Electric Code
      c. Cable manufacturer must be ISO-9002 Certified
   5. Cable shall meet the following performance specifications:
      a. Temperature Rating- -20 to +60 deg C
      b. Maximum continuous current per conductor- 9.5 Amps
      c. Maximum Operating Voltage- 300v RMS
      d. Maximum Conductor DC Resistance @ 20deg C- 2.7 Ohms / 1000'
      e. Normal inductance- .20 Micro H/ Ft
   6. Color Pairs
      a. The conductor colors shall be black, red, white and green.
   7. The cable is Belden Wire and Cable, #1810A or equal.

F. Analog Multi-Pair Microphone Snake Cable
   1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
   2. The cable shall be composed of the specified number of paired conductors called for on the plans and contract documents. Cable shall be #24 AWG tinned copper conductors, with a #18 AWG stranded tinned copper drain wire.
   3. Cable shall contain an individual overall aluminum foil polyester tape shield with 100% shield coverage. An individual polyvinyl chloride jacket shall enclose individual pairs.
   4. Pair color code shall be black and red.
   5. The cables shall meet or exceed the following standards:
      a. Underwriters Laboratory
      b. National Electric Code

c. CEC Type CMR FT4
d. Cable manufacturer must be ISO-9002 Certified
e. Cable shall meet the following performance specifications:
1) Temperature Rating - -30 to + 75 deg C
2) Continuous current per conductor - 1.05 Amps
3) Maximum Operating Voltage - 300v RMS
4) Normal capacitance between conductor of pair @ 1KHZ- 31 PF/FT
5) Normal capacitance conductor to shield - 58 PF/FT
6) Normal Conductor DC Resistance @ 20deg C - 22 Ohms / 1000'
7) Normal Shield DC Resistance (pair) @ 20deg C - 18.9 Ohms / 1000'
8) Normal impedance - 50 Ohms @ 1 MHZ

6. The cable is:
a. 4 Pair Snake Cabling- Belden Wire and Cable #1408R or equal.
b. 8 Pair Snake Cabling- Belden Wire and Cable #1410R or equal.
c. 12 Pair Snake Cabling- Belden Wire and Cable #1411R or equal.
d. 16 Pair Snake Cabling- Belden Wire and Cable #1412R or equal.

G. RGB Bundled Cable- 3 & 5 Conductor #26 AWG
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of the specified number of conductors called for on the plans and contract documents. Cable conductors shall be #26 AWG bare copper conductors with polyethylene insulation.
3. The cable shall contain a bonded aluminum foil-polyester tape-aluminum foil shield, plus tinned copper braid shield with 93% shield coverage. An individual polyvinyl chloride jacket shall surround cable.
4. Color code shall be red, green, blue, white, yellow (5 conductor); red, green, blue (3 conductor).
5. The cables shall meet or exceed the following standards:
a. Underwriters Laboratory- UL 1354, & UL -2668
b. National Electric Code
c. CEC Type CMR FT4
d. Cable manufacturer must be ISO-9002 Certified
6. Cable shall meet the following performance specifications:
a. Temperature Rating- -40 to + 60 deg C
b. Normal Capacitance- 17.3 PF/FT
c. Maximum Operating Voltage- 300v RMS
d. Structural Return Loss- 25DB MIN, 10-40 MHZ
e. Normal Conductor DC Resistance- 41.5 Ohms / M Ft
f. Normal Shield DC Resistance- 8.6 Ohms / M FT.
g. Normal impedance- 50 Ohms @ 1 MHZ
7. The cable is
a. 5 Conductor- Belden Wire and Cable #1418B or equal.
b. 3 Conductor- Belden Wire and Cable #1164B or equal.

H. HDMI cables shall all be a min of 24AWG, and be of appropriate size/type for the distances required.

I. RG11, 75 Ohm Solid 14AWG
1. The coaxial cable must be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a solid 14 AWG bare copper conductor insulated with gas injected foam high density polyethylene, surrounded by a Polyethylene jacket. Cable shall be RG/11/u
3. Cable shall have a bare copper braid shield (97% coverage).
4. The cables shall meet or exceed the following standards:
a. EU CE Mark

b. National Electric Code- CATV or CM Rating
c. UL-1581 Flame Test Rating
d. Cable manufacturer must be ISO-9002 Certified

5. Cable shall meet the following performance specifications:
   a. Conductor diameter: 0.064”
   b. Impedance: 75 Ohms
   c. Attenuation, Max:

1 MHZ - .2 DB/100’	10MHZ - .4 DB/100’
50MHZ - .9 DB/100’	100MHZ - 1.3 DB/100’
200MHZ - 1.9 DB/100’	400MHZ - 2.9 DB/100’
700MH Z- 4.1 DB/100’	900MHZ - 4.8 DB/100’
1000MHZ- 5.2 DB/100’	

   d. Structural Return Loss- 5-450MHZ, 23DB
   e. Maximum Operating Voltage- 600v RMS
   f. Normal Conductor DC Resistance @ 20deg C- 2.6 Ohms / 1000’
   g. Normal Shield DC Resistance @ 20deg C- 1.1 Ohms / 1000’

6. The cable is Belden Wire and Cable, Model 8213 or equal. Provide from MDF plywood backboard at CATV demark location to TV Head End plywood back board. Leave terminated and coiled 25’ in each area.

2.7 Termination Hardware

A. Modular 8 position modules: (Equipment control)
   1. Termination hardware shall be designed with an integral locking mechanism, which upon insertion of a modular plug provides maximum pullout strength at the plug/jack interface.
   2. All modular 8-position jacks shall be RJ-45, T 568B wired.
   3. The jacks shall meet or exceed the following standards:
      a. ANSI/TIA/EIA-568-B.2-1 Commercial Building Telecommunications Cabling
      b. Standards, Category 6
      c. IEC 60603-7
      d. FCC Part 68, Subpart F
   4. The modular jacks shall meet the following electrical performance and certification requirements:
      a. The modular jacks shall meet all ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standards and ANSI/TIA/EIA-568-B.2
      b. Near End Crosstalk (NEXT) and Attenuation measurements shall be made per ANSI/TIA/EIA-568-B.2-1 and ANSI/TIA/EIA-568-B.2.
   5. The modular jacks shall meet the following requirements:
      a. Connector-insulation displacement connectors shall be capable of accepting 24 gauge AWG solid conductor wire.
      b. Terminated in accordance with EIA-568B specifications.
      c. Data and Voice jacks shall be RJ45 (must be gray).
      d. In addition to complying with the above listed standards, all Category 6 termination hardware shall meet or exceed the following criteria: ANSI/TIA/EIA-568B.2-1,ISO/IEC 11801, IEC 60603-7, FCC Part 68 Subpart F
   6. The jack shall be approved to work in all applications up to 100 Mb/sec, including, but not limited to 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), proposed 155 Mb/sec ATM, 16 Mb/sec token ring, 10 Base T and 4Mb/sec token ring.
   7. The modular jacks shall use the color code indicated below:
      a. Data- Blue
      b. Voice- White

c. Control- Gray

8. The manufacturer of modular jacks is Panduit, mini-com series #CJ688TP or equal.

B. F-Type Module:
1. Module shall be F-Type with a Female to Female connection. Module shall be colored electric ivory.
2. Module shall snap, insert, or otherwise connect to work with specified faceplates.
3. The jacks shall meet or exceed the following standards:
   a. UL Listed
4. Manufacturer of f-type module is Panduit, mini-com series #CMFBA or equal

C. BNC Coaxial Coupler-Type Module:
1. Module shall be 75 OHM BNC coupler with a Female to Female connection. Module shall be colored electric ivory.
2. Module shall snap, insert, or otherwise connect to work with specified faceplates. The jacks shall meet or exceed the following standards:
   a. UL Listed
3. Manufacturer of BNC Coaxial module is Panduit, mini-com series #CMBA75 or equal.

D. F-Type Connector
1. Module shall be a F- Type Male CATV pin connector with braid-crimp cable attachment.
2. Module characteristics:
   a. Impedance - 75 Ohms
   b. Return Loss - 40db @ 1.0GHZ
   c. Insertion Loss - .2db @ 1.0 GHZ
3. Pin type has a standard 5/8-24 UNEF thread. Full cable retention over temperature range of –40F to +140F
4. Manufacturer of F-Type Connector is Amphenol, # 531-F11QP or equal.

E. BNC Type Connector
1. Module shall be a 3 pole male cable receptacle, with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 5 m Ohms
   b. Dielectric strength: 1500 V dc
   c. Rated voltage: 250 V ac
   d. > 1000 mating cycles lifetime
   e. Capacitance between contacts: 4 pF
3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MD-L-1 or equal.

F. XLR Type Microphone Jack
1. Module shall be a 3 pole male cable receptacle, with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 5 m Ohms
   b. Dielectric strength: 1500 V dc
   c. Rated voltage: 250 V ac
   d. > 1000 mating cycles lifetime
   e. Capacitance between contacts: 4 pF
3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MD-L-1 or equal.

G. 3 pole XLR Cable Connector
1. Module shall be a 3 pole male cable connector with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 3 m Ohms
   b. Dielectric strength: 1500 V dc

c. Rated current: 16A
d. Capacitance between contacts: 4 pF

3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MX or equal.

H. RCA Type Connector
1. Module shall include a RCA Connector at one end and a solder connection at the other.
2. Module shall be colored black
3. Module shall snap, insert, or otherwise connect to work with specified faceplates.
4. The jacks shall meet or exceed the following standards:
a. UL Listed
5. Manufacturer of RCA module is Panduit, Amp, Neutrik or equal.

I. XLR Type 6 pole jack – Intercom V8 and TC suite rack panel
1. 6 pole female receptacle
2. Solder cups
3. Black metal housing, gold contacts
4. Metal housing, duplex ground contact
5. Neutrik NC6FD-LX-B or equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with the work of this section until conditions detrimental to the proper and timely completion of the work have been corrected in an acceptable manner.
B. Notify Architect and Owner of any site problems preventing installation.

3.2 INSTALLATION

A. Verify exact locations of equipment with the architect and owner before installation and other trades necessary to provide a complete and operational system. Immediately notify the Owner and architect of any discrepancies.
B. Coordinate all work and service with the electrical contractor.
C. Coordinate final connection of power and ground wiring to equipment with electrical contractor. Power and ground wiring shall terminate inside sound rack and provide for interconnection to the building's electrical system.
D. Equipment and enclosures shall be plumb and square. Permanently attach equipment, except portable equipment, firmly in place to the structure. Supports shall be adequate to support their loads at a safety factor of at least three.
E. Prevent and guard against electromagnetic and electrostatic hum.
F. Make connections with accepted connectors and terminal blocks equal to Cinch 140-142 or TRW 142 series. If a device has screw terminal connections in addition to other types of receptacles, terminate cables to screw terminals using accepted spade lug type terminals. Tin all conductors at screw terminals of low level equipment.
G. According to IEC-268 standard, XLR connectors at equipment shall be wired pin 2 hot (high), pin 3 low, pin 1 shield. Drop shields at the outputs and connect at the respective equipment inputs to maintain ground integrity. Connections and signal hookup to low and medium level equipment shall be done in a balanced configuration. Unbalanced wiring without interfaces to balance signal with respect to ground is not allowed.
H. Provide visible termination resistors and not concealed within connector housings or inside devices being terminated.
I. Provide polarity at loudspeaker connections and use the same wire color code for speaker wiring throughout the project. Make joints and connections with rosin-core solder or with mechanical connectors or with terminal strips accepted by the A/E.
J. Pre-wire racks before delivery to project site. Wiring shall be according to standard broadcast practices.
K. Avoid damage to the cables and to the equipment. Isolate cables carrying signals at

different levels and separate to restrict channel bleed through and feedback oscillation in any amplifier section. Keep the following wiring separated in groups of conduit:

1. Microphone level circuits (level below -20dbm).
2. Line level circuits (up to +30dbm).
3. Loudspeaker circuits (above +30dbm).
4. Power circuits.

L. Use insulating "spaghetti" and heat shrink tubing at each connection throughout system with an exposed drain wire or any other exposed shield. Use insulating collars consisting of heat shrink on rack terminations. Positively bond multiple racks together. Bond the racks to the isolated ground buss as applicable.

M. Insulate audio wiring and equipment racks from the building conduit system where applicable.

N. Grounding shall comply with isolated ground conventions described in:

1. "Establishing A Clean Ground" in Sound and Video Contractor, July, August, and December 1988 issues.
2. Sound System Engineering by Don and Carolyn Davis, Book Two.
3. Audio Cyclopedia published by Howard & Sams.
4. Sound Systems Design by Howard Giddings.

O. Mount XLR connectors to their plates using Phillips oval head screws having a matching finish to the custom panel.

P. Mount equipment to racks using black Phillips screws and black anti-scuff washers.

Q. Engrave provided panels and paint fill.

R. Conceal wiring unless absolutely impossible within the public spaces. Perform installation of wire, conduit, junction boxes, or other fittings in a professional manner consistent with these specifications and Owner's requirements.

S. If any conflicts or omissions occur as a result of the communications subcontractor's unsuccessful coordination of the above-mentioned work, it shall be the communications subcontractor's responsibility to correct and to furnish and install any additional material that may be required at no additional cost to the Owner.

3.3 FIELD QUALITY CONTROL

A. Conduct preliminary checks and testing before performance testing and after completion of related or adjacent work of other trades. Verify safe and proper operation of components, devices or equipment, nominal signal levels within the systems, and the absence of extraneous or degrading signals.

B. Perform the following verification and testing procedures:

1. Provide proper grounding of devices and equipment per manufacturer's recommendation.
2. Integrity of insulation, shield terminations, and connections.
3. Proper provisions of power to devices and equipment.
4. Integrity of soldered connections.
5. Absence of solder splatter, solder bridges, debris of any kind or tools.
6. Proper routing and dressing of wire and cable.
7. "Wire checking" of circuitry, including phase and continuity, concerning cable designations on run sheets, field and shop drawings.
8. Determine the proper sequence of energizing systems to minimize the risk of damage.
9. Measure and record impedance of loudspeaker lines terminating at equipment racks at 1000 Hz, with loudspeakers connected to their respective lines at "full on".
10. Measure and record overall system hum and noise level of each input channel with controls set so that -50dbm microphone input or +4dbm input would drive the system to full amplifier output. Terminate inputs with resistors (150 or 600 ohms) for this test.

11. Measure and record electrical frequency response for each input channel through the power amplifier. Required is flat response with permissible deviation of + 2db within the range of 60Hz to 15Khz.
12. Check polarity of loudspeakers by applying music program or constant power per octave (pink) noise to the system and walking through the transition areas of coverage from one loudspeaker to the next.
    a. Transition shall be smooth with no apparent shift in source from one speaker to the next. This test will be performed by the Owner at final inspection.
    b. Apply sine wave signal sweeping from 60Hz to 5000Hz and at a level of 10db below full output, and listen for rattles or objectionable noises. Correct if apparent.
13. Drive system with broadband, constant power per octave (pink) noise, and measure the SPL at the 4Khz octave band.
    a. Adjust noise level until the meter readings are between 80 and 90db.
    b. Take readings at seated ear height.
    c. Perform listening tests and readjust system for a pleasing overall sound.
    d. Use parametric equalizer and “ring out” system to eliminate the major portions of feedback from foldback speakers.
    e. Demonstrate to Owner’s operator the adjustment of speakers as necessary to achieve minimum deviation over entire area covered by this system.
14. Check system to assure freedom from oscillations or stray RF pickup.
    a. Check inputs with no signal and 100Hz sine wave signal driving system to full output.
    b. Detect unwanted signals on oscilloscope at rack termination and at loudspeaker connected at farthest distance from rack for each loudspeaker line.
15. After successfully energizing the systems, make preliminary adjustments and document the setting of controls, parameters of corrective networks, voltages at key system interconnection points, and gains and losses, as applicable.
    a. Tabulate data along with an inventory of test equipment, a description of testing conditions, and a list of test personnel as itemized below.
    b. Copies of preliminary test data shall accompany copies of performance testing data as part of the final submittal.
16. Verify the performance parameters of the individual system following established professional procedures, in addition to those specified.
17. Document acceptance testing, calibration, and correction procedures as specified with the following information:
    a. Performance date of the given procedure.
    b. Condition of performance of procedure.
    c. Type of procedure and description.
    d. Parameters measured and their values, including values measured before calibration or correction, if applicable.
    e. Parameters associated with calibration or corrective networks, components, or devices.
    f. The names of personnel conducting the procedure.
    g. The equipment used to conduct the procedure.
    h. Provide permanent labels on controls, as applies, to indicate correct setting after performance testing and adjustment procedures have been successfully completed.
    i. Provide documented voltage settings, hum and noise measurements, final elevations, and angle information for racks and loudspeakers as applicable.
18. Equalize system to provide full range operation and for commission foldback speakers. The final system response shall be set flat from 100Hz to 2kHz, +2dB, and then rolling off 3dB per octave to 10kHz. Average SPL response shall be 80

to 90 dB, “A” weighted and loss of consonants shall be less than 12 percent.

19. Check system to be free from rattles, buzzes, and objectionable distortion. Correct objectionable distortions and retest.
20. Provide operator support at first 2 uses of system after work is completed and accepted per this specification. Support limited to 8 hours of time on site. Provide emergency contact procedures in case of system trouble.

C. Upon completion of the Work and compliance with requirements, the Owner’s representative will verify test data as part of the acceptance procedure. Provide personnel and equipment, at the Owner’s representative convenience, to demonstrate any aspect or parameter of performance and to assist with such tests.

D. Failure of any component or system to meet specifications shall require immediate remedial action. In the event that material, device, equipment, system, or manual skills are found unacceptable as late as 15 days before the substantial completion date, Installer shall provide the temporary installation of operational components or systems satisfactory to the Owner until acceptance of the Work.

3.4 Testing and Acceptance Criteria

A. UTP Cabling

1. At a minimum, provide the results from the following performance tests on all installed UTP data cabling as outlined in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2 Communications subcontractor will measure and report (in hard paper copies and electronic format) the following link parameters for the permanent link and channel test configurations as defined in TIA/EIA-586-B.1
    a. Wire Map including shield connection if present
    b. Length
    c. NEXT loss, pair-to-pair, measured from local end
    d. NEXT loss, pair-to-pair, measured from far-end
    e. NEXT loss, power sum, measured from local end
    f. NEXT loss, power sum, measured from far-end
    g. EFLEXT, pair-to-pair
    h. ELFEXT, power sum
    i. Return loss, measured from local end
    j. Return loss, measured from far-end
    k. Propagation delay
    l. Delay Skew
2. In addition to these, any performance tests required by the cabling product vendor for issuing and honoring the required 15-year warranty must also be performed.
3. Approved Level II minimum accuracy testing equipment must be used for all tests.
4. Furnish all personnel, labor, meters, instruments, cable, connections, equipment and apparatus necessary for making all tests.

B. Test Plan

1. All test equipment, test procedures, and testing techniques shall be specified in the acceptance test plan and will require approval prior to execution.
2. Tests shall be conducted by the communications subcontractor in accordance with the approved Test Plan.
3. The purpose of this testing is to verify that the installed system meets all specified attenuation and bandwidth requirements and is capable of being used for its intended purpose.
4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District’s technical representative for approval, prior to shipment to the site.
5. The communications subcontractor shall prepare a test plan which provides a

detailed outline of all testing to be accomplished.

6. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones) , specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

C. Test Results

1. Each test sheet shall have a sign-off blank for the communications subcontractor, as well as the District's technical representative. Copies of the completed test forms or test results shall be delivered according to the shop drawing procedures.
2. The communications subcontractor shall maintain an accurate test record during all field tests. Samples will be provided to the awarded vendor. Any communications subcontractor developed format for recording test data shall be submitted for approval as part of the test plan.

3.5 CLOSEOUT

A. Perform remedial work to correct inadequate or unacceptable conditions of, or relating to any portion of the Work, as determined by the Architect or Owner, at no expense to Owner.

B. Furnish equipment to the Board along with complete manuals and connection drawings of the materials presented. Equipment shall be in the original manufacturer's packaging, complete with included instructions and miscellaneous manual and documents.

C. Present, review, and clarify materials to the Owner, Owner's representative and operating personnel and fully demonstrate the operation and maintenance of the systems, equipment, and devices as specified.

D. Check, inspect, and if necessary adjust systems, equipment, devices, and components specified, at the Owner's convenience, approximately 60 days after the Owner Acceptance of this work.

E. Further adjustments or if additional work becomes evident during acceptance of the system, the communications subcontractor will continue his Work until system is acceptable at no additional cost to the Owner. If approval is delayed because of defective equipment, failure of equipment, or installation to meet the requirements of these specifications, the communications subcontractor shall pay Owner expenses for additional time during any extension of the testing and acceptance period.

3.6 DEMONSTRATION

A. Provide on-site training to the facility's personnel (faculty and staff) on how to set-up, operate, and test systems for proper function in accordance with Paragraph 1.11.

END OF SECTION

Section 27 50 00

DISTRIBUTED COMMUNICATIONS AND MONITORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. Any and all cabling mentioned herein and required to complete the work of this section shall be coordinated with the communication subcontractor of this section, and provided and installed by the Structured Cabling communication subcontractor of section 27 10 00 so long as it does not void any manufacturer warranty. The communication subcontractor of this section is responsible for any cabling required by the manufacturer to ensure manufacturer’s warranty. The scope of work of this Section consists of the designing, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:

1. Public Address System, including but not limited to:

a. Public address system amplifiers, zone controls, back boxes, and all equipment, cabling and support required to interface the Public Address System to the Owner’s Telephone System (Phone System Not included in this contract - coordinate with Owner).

b. Public Address System Speakers, flush and surface horn ceiling mounted interior, flush horn wall mounted, exterior. Provide and install override in coordination with 27 40 00 communication subcontractor.

c. Cabling to support the Public Address System (NOTE: any category 5/6 cable must be Gray).

d. Equipment rack or cabinet

e. Volume attenuators (A symbol in a circle) where shown on the drawings to adjust the PA speaker sound level.

f. GPS Master and Secondary Clock System, clocks and cabling.

g. Provide PA override signal to local sound systems (Gym, both Student Dining, Auditorium and video wall system. Coordinate with 27 40 00 communication subcontractor.)

h. PA integration with Access Control system. Coordinate and program event (coordinate event with Owner) in PA system to be triggered by access control contact closure (panic button). Integrate cabling provided by Access Control into PA system. Coordinate with 28 00 00.

i. Provide PA administrative stations (one at each A3 location, qty 2 (both in 101B). Coordinate cable required and jacks for termination with 27 10 00. Provide and terminate jacks in A3 faceplate.

j. PA System shall be independent from the phone system and shall not rely upon a phone system to function; however the PA system shall be integrated with the phone system to allow the phone system to initiate pages to zones.

k. Program paging zones in accordance with owner direction. Coordinate with owner. At a minimum, each interior floor, the exterior, Gym, Auditorium and both Cafes shall each be an independent zone.

l. All sound systems, including classrooms, (in addition to above systems) require an input from the PA system to mute the audio of the sound system. Provide input in coordination with 27 40 00 communications subcontractor for sound systems (contact closure, voice signal, or similar)

m. Where noted on the drawings, provide a dedicated amplifier in the local IDF to provide 7.5w minimum to each PA speaker (HS and FS symbols) in the space. See Gym, Auditorium, Library Media Seminar room and Student Dining. Provide an amplifier for each location. None of the HS or FS speakers shall be used for talk back.

n. Technology drawings symbols to be provided under this section, as shown on T2.0 and T2.1 are: SP, ES, FS, HS, A (attenuator), C, C16, A3 locations for PA Admin Phone and Jack, and any other symbol reasonably determined to be part of the PA system.

o. All equipment described in this Section shall be provided, configured, tested, programmed and warranted by a manufacturer certified communications subcontractor. Communications subcontractor shall provide proof of manufacturer certification.

p. Provide every required part of system complete in detail and operable in unison with all other sections of this specification, resulting in a complete Distributed Communications system.

q. If a ceiling space is black, the locations require the back boxes and grills of PA speakers to be painted black by the communications subcontractor of this section to match the black or exposed ceiling in those spaces.

B. Actual control room and rack layouts will be based upon the specific designs submitted by the communication subcontractors. Needs for equipment, specific speakers, and other equipment will be dependent on actual product manufacturers. Communication subcontractors shall coordinate room layout, actual speaker and equipment placement and programming options with owner prior to installation.

C. No hallway, classrooms or spaces are air plenums. No cabling is required to be plenum rated.

1.3 RELATED SECTIONS

A. Field Painting: DIVISION “FINISHES”
B. SECTION 01 23 00 - ALTERNATES
C. Electrical: DIVISION 26 00 00
D. All Communication Sections, 27 and 28.
E. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking
F. SECTION 11 61 00 – THEATER EQUIPMENT for PA mute/override of Auditorium sound system

1.4 SECTION INCLUDES

A. Central processor assembly

B. Administrative consoles (at A3 locations on the drawings. Coordinate connector in A3 faceplate and cable to MDF or as per system requirements for remote locations with 27 10 00 communications subcontractor)

C. 12” analog clocks (C symbol) and 16” analog clocks as noted on the drawings (C16).

D. Digital Clocks

E. Bell/Class change signaling system.

F. Public Address/intercom System

G. Controls, Amplifiers, and Terminal Equipment

H. Power Supplies

I. Battery Backup for System Programming

J. Program Distribution System.

K. Master Clock System

L. Telephone controlled intercom system

M. Web interface for bell schedules

N. Programmable, individual control of inputs and outputs

O. Ceiling/Wall Mounted loudspeaker assemblies

P. Surface clocks and clock and loudspeaker baffles

Q. Accessories

R. Wiring

S. Interior and Exterior Enclosed Horn Type PA Speakers

T. Speaker volume attenuators where shown on the drawings.

U. PA system shall not rely on a phone system to fully function.

V. Dedicated amplifiers for PA speakers in both cafes, auditorium, and gym.

1.5 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00- SUBMITTAL PROCEDURES:

B. Product Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions for each item furnished hereunder. Ensure submittal is tabulated with index referencing the specification sections. Non tabulated and indexed submittal shall be returned without action.

C. Alternate systems being submitted for this bid shall provide a tabulation specification clearly comparing the submitted item with the specified item, being able to refer to all written expressed functions and capabilities. Specification sheets shall be submitted on all items including cable types.

D. Shop drawings, detailing the communications network system including, but not limited to, the following:

1. Device locations and wiring (PA speakers, administrative consoles, attenuators, clocks)

2. Interconnections (access control inputs, sound system mute outputs)

E. Provide a riser diagram for the system showing in technically accurate detail all connections, interconnections, and all provisions available and made for adaptability of all specified future functions and including all calculations, charts, and test data necessary to demonstrate that all systems and system components deliver the specified signals, grades, and levels at all required points and locations.

F. Manufacturer Certificate and Certified Training Certificates of communication subcontractor who will be providing, programming and warranting the equipment.

G. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials on CD and videos of all training provided on DVDs. Communications subcontractor shall provide recording of training provided.

5. Estimated costs for maintenance and software assurance for the system on a yearly basis.

6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse).

7. Warranty certificate with contact numbers with appropriate start and stop dates

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for the system, that specializes in PA systems with a minimum of 5 years in the industry.
B. Communication subcontractor: Company specializing in Distributed Communications and Monitoring Systems, with a minimum of three years experience on systems of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project. Provide valid current proof of manufacturer's certification.

1.8 REGULATORY REQUIREMENTS

A. The entire installation shall comply with all applicable and safety codes. All central equipment and additional applicable equipment shall be Listed by Underwriters' Laboratories, per US requirements Note: Furnish an original, dated specimen of the test agency's listing card with the submittal.

B. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must be Federal Communications Commission (FCC) and DOC CSA standards C108.8 (Electromagnetic Emissions) compliant. Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract. Note: Provide documents supporting and verifying compliance.

C. Systems shall be considered non-compliant unless they completely meet the criteria as outlined in this section. All supporting documentation shall be included as part of the initial submittal package. Letters regarding "future approval" or "approval pending" shall not be considered.

1.9 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, travel and labor shall be warrantied for a period of 36 months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and a help desk. Provide qualified technicians that are experts in Telecor Systems, and who are familiar with the work at the site, within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the

first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this 36 month period.

H. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

I. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

J. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, in the close out submittals.

K. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

L. Service Calls: Provide 24 hours of service calls on system for the school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Warranty work is not included in the service call time.

1.10 MANUFACTURERS

A. Telecor Inc
B. Rauland
C. Bogen

PART 2- PRODUCTS

2.1 PUBLIC ADDRESS SYSTEM

A. To establish a standard of quality, design and function desired, Drawings and specifications have been based on the T2 equipment by Telecor Inc

B. The Public Address System shall consist of the Central Control Unit, Administrative Consoles, PC-Based Graphic User-Interface (GUI) web-based editor, rack equipment and all other necessary devices that are required to create a complete and operational system such as Speakers, Horns, Amplifiers, and Visual Message Devices. All Public Address main equipment including card cages and all cards, power amplifiers, program sources, and other equipment, shall be rack mounted in the MDF room. Most system programming of Public Address and Master Clock features shall be accomplished remotely, by an Administrative Console and GUI located in the Main Office area or over the LAN/WAN. It shall not be necessary to attend to the main equipment in the Head End for normal day-to-day operation of the system. The system shall be a 25-Volt two-way paging system providing paging zones as indicated and determined by the Owner. The system shall be of

modular design utilizing plug-in circuit cards to enable quick on-site replacement or addition of components for system expansion and modification. The system head end equipment shall be rack-mounted in the MDF where shown on the drawings with side panels and stationary platform base. Provide shelves, doors, blank panels, AC power distribution, and other equipment or materials to support all equipment and fill empty rack space. System shall be comprised of all solid-state electronics, utilizing a microprocessor-based central processor unit, power supplies, audio interface cards, control cards, input/output cards, telephone interface cards, transformers, paging amplifiers, and other equipment and materials for a complete system, to include equipment and installation to interface with the Owner's VoIP telephone system. The interface must comply with loop-start central office (CO) trunk standards in North America as defined by Bellcore and/or industry-standard 2500 analog station ports.

C. The system must include a GUI application that allows for the operation of the System from a Windows®-based PC on the network. Provide equipment/options to accomplish this requirement. Provide networked PC, (coordinate location with Owner), keyboard, mouse, and 21" LCD Monitor if required. PC shall exceed manufacturer recommended specifications. This software package shall utilize an easy-to-use graphical user interface (GUI), quick graphical access to paging, and program distribution. The software shall also allow easy activation of class change schedules. Emergency operations shall be simplified through this software application by allowing stored audio files and alphanumeric messages for message displays to be activated from the GUI. The GUI shall allow common operations such as daily announcements to become automated with the use of the GUI, removing multi-step console set ups. While all operations are conducted from the PC screen, the Administrative Console or Telephone handset shall provide the means for originating voice communications to selected locations. The Software GUI shall provide:

1. Simple Routine Call Processing
2. Emergency Functions
3. Paging
4. Audio Program Distribution
5. Enabling and Disabling of Schedules and Bell Scheduling

D. The GUI shall provide an efficient and reliable method of notifying the occupants of a facility of critical situations. A variety of emergency tone signals that reside within the Intercom/Paging System shall be activated by clicking on pre-programmed buttons on the PC GUI screen, initiating the transmission of tone signals to speakers. A 'lockdown' audio message as per Owner direction, with owner selecting the appropriate tone, shall present on the system by a contact closure from the access control system. Provide/install cabling to access control system and coordinate integration with access control 28 00 00.

E. The main system shall include a Telecor T2/XL head-end, a networked PC with Microsoft Windows XP or Vista running Telecor's Visual Console software (if required for the Telecor GUI), a monitor, data entry keyboard, control console, serial connections to in-house alert systems, UPS power backup (provide one UPS for headend unit (head end unit must be 208v 30 amp single phase with twist lock L6 plug) and one for visual console PC, if provided), interfaces for network access (an IBP-1, IP Broadcast Interface card with site license; and a CNI-1-XL/T2 Notification Interface device), a Category 6 structured cabling system with C5PPL Patch Panels in IDF's, and all associated system components to provide:

1. Direct dialing, two-way "amplified voice" communications between all locations equipped with Control Console, and/or telephone system handset, and all locations equipped with a public address system speaker; excluding corridor speakers.

2. An Administrative Control Console (located at all A3 symbols) for facilitating all Public Address System announcements and programming, to include but not be limited to: Emergency all-call; paging zone and number assignments; call-in priority levels with tone characteristics; Master

Clock event and tone signaling; monitor and reporting on call-in line faults; and manually distribute unique tones to all zones and speakers in the system. Emergency paging from any call button shall display on all admin consoles

3. A rack mounted Tel-Comm Server provides network connectivity from authorized PC's to remotely control or program the T2/XL systems. Tel-Comm Server provides remote system diagnostics and access to activity log files on the T2/XL system. It also provides support for the Visual Consol program and integrates the functionality of an MCC-300 Administrative Consoles into the framework of a PC. Audio files that are used for daily as well as emergency announcements and music files can be stored in the Tel-Comm Server for retrieval. The server also provides for the synchronization of the T2/XL to a master time keeping source. This can be a time source within the facility or an external time server via the Internet.

4. Connection to a local building digital PBX or VoIP telephone system (phone system by Owner), allowing any telephone handset that is part of the telephone system to page and conduct hands-free, open-voice communication with any speaker in the system; the Control Console; or any other classroom telephone. The Connection to the local phone system shall not diminish or restrict any of the capabilities of local telephone system. Public Address System interfaces shall allow any programmed telephone to perform but not be limited to the following intercommunication system functions: all-call; zone call; intercom call to classroom speakers, and distribute class change signals.

5. User-programmable zone paging to all classroom and office speakers using microphone, Control Console, or telephone. Public address zones shall be software programmable to include 1- and 2-digit numbers. Zone paging shall be independent of time and program zones and shall provide easy access to groups of zones or all-zone pages.

6. Distribution of general announcements over School loudspeakers using a microphone, Control Console, or telephone handset, on an All-Call basis, pre-selected zone basis, or multiple-zone basis to any paging zone. Speaker assignments to any zones shall be programmable from the Web Editor.

7. Distribution of emergency paging announcements over school loudspeakers using a microphone, Control Console, GUI or telephone handset. Emergency announcements shall have the highest priority over all other system functions, including the Local Audio Systems. Emergency announcements shall automatically disconnect and override all Local Audio Systems. Provide programming source to override local audio systems in Auditorium, Cafe, PE Center, Library Media Seminar Room and Gym. Coordinate with 27 40 00 communication subcontractor.

8. Selection and monitoring of individual program sources (Microphone, AM/FM Tuner, Tape or CD) and distribution by the Admin Console.

10. Control Console programming of administrative microphone for control and distribution of public announcements, to eliminate the need to go to the central electronics for microphone set up. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system, including Local Audio Systems (emergency pages only). Microphone shall transmit to all rooms or specific speaker zones as programmed in the system software. Provide and install Shure model 522 or equal in admin area.

11. The capability of multiple open-voice intercom paths. Intercom paths shall be global.

12. Automatic gain-control of intercom speech to assure constant speech level.

13. Automatic sounding of a warning tone over any loudspeaker selected for two-way communications to alert the classroom teacher to an incoming announcement.

14. A minimum of two channels for intercom communications or audio program distribution. The System shall be user-programmable to allocate, upon demand, either of the two channels for intercom or audio program.

15. The ability to monitor the school building either on or off the premises from a single telephone.

16. Audio program distribution to eight different areas of the building selected by the Control Console. Inputs shall be provided for five (5) low-impedance microphones, tuner, tape player and auxiliary source. Program material shall include audio programs from standard AM/FM tuner, tape deck, CD player, or auxiliary source. Control Console shall have the ability to monitor program sources being distributed. Coordinate location of antenna(e) with architect. Locate and install for optimal performance.

17. Audio Source equipment shall have the ability to be located remotely from the main system control electronics, and shall have the ability to distribute two channels of audio simultaneously if so desired. School shall be equipped with (1) rack-mounted AM/FM tuner (with iPod dock capability), (1) rack-mounted CD player. Ipod must be able to interface with sound system to provide sound over PA system to all or selected zones.

18. RS232 Input/Output Interface, Personal Computer, LAN/WAN, Modem, and Printer for monitoring activity within System and for displaying and printing system management information. System shall perform diagnostics, or logging transactions either on or off premises.

19. The ability to interface to the power supplies of door strikes and to allow remote control of door strike through the paging system.

20. Time Signal tones of an integrated Master Clock System to be distributed throughout zone(s) selected for time signaling over programmed loudspeakers on a manual or automatic basis.

21. A Global Positioning Satellite Receiver (GPS) shall be provided and installed. By receiving accurate time signals from 24 satellites in orbit around the earh, the 2400-SR Receiver provides for an alternative time base for Telecor's 2400 Series of Master Clocks and the 2490 Transceiver used with Telecor Wireless Clocks. Conduit from the MDF to the roof is available for installation of GPS antennae. Seal all penetrations.

22. Power amplifiers that provide a minimum power capacity of 2 watts per cone speaker location, 7.5 watts per interior horn speaker, and 15 watts of power per exterior horn type speaker location.

23. Cabling that is specified by the manufacturer, which provides shielding of conductors so that the Public Address System does not interfere with the Telephone Systems and Telephone System cabling.

24. The system must be compatible with a structured cable plant with MDF and IDF and CAT6A cabling.

25. Classroom components (including a speaker and clock) may all be connected to the system via a single CAT6 cable drop for each classroom/location to either the MDF or IDF in a Networked solution.

26. Pre-announce tones will alert the listeners of incoming calls with distinct tones for each priority level. To prevent unauthorized monitoring, the tone will sound whenever an area is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone repeat function from the administrative console if it is not desired.

27. Emergency and All Call paging and a minimum of 16 zones of group paging. The paging zones shall be independent of the time tone and audio program distribution zones. Systems sharing zones for both paging and tone shall not be acceptable.

F. The system shall be capable of monitoring 16 different sections of the building, either on the premises from a control console, or off premises from a telephone instrument.

G. Distribution of paging announcements can be made from any administrative control console, GUI, telephone, or dedicated microphone set-up.

H. Emergency announcements shall have the highest priority over any other system function and seize all system loudspeakers regardless of their current mode of operation.

I. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system and transmit the microphone audio to all buildings or specific speaker zones, as programmed into the system software.

J. System will provide Emergency and All Call Paging and a minimum of 16 zones of group paging. The paging zones shall be independent of the tone signal and audio program distribution zones.

K. Pre-announce tones will alert zones of incoming pages with distinct tones for each priority level.

L. The system must have the capability of distributing audio program sources from any administrative telephone or authorized building telephone. Program distribution shall be accomplished on an all zone, selected zone, or individual zone basis.

M. The system shall support the automatic distribution of tone and text signals to all selected areas.

N. The system shall support a minimum of 1536 events and 16 schedules. Building zones shall be used to select which areas receive the tone. They must be totally independent from page zones and program zones.

O. All signal programming shall be accomplished from a PC utilizing a standard web browser. The system shall support running all time schedules concurrently.

P. The duration of the tone, as well as frequency, burst length and output level shall be software programmable from a web browser.

Q. All system tones shall be user-programmable for the following durations in seconds: 2, 3.5, 5,6,8,10,12.

R. The system shall be capable of an open-voice intercom path used for monitoring, emergency paging, and intercom.

S. The system shall have an IP-based Broadcast Interface capable of receiving pre-recorded or live messages from the district office (hardware at district office not in contract).

T. Corridor speakers, and outside horns in each building shall be combined into groups of owner's preference. There must be 16 independent software paging zones that each circuit may be a part of. Each individual circuit must also have the ability to be paged independent of the software zones.

U. Station wiring shall be connected to the system using insulation displacement connectors to allow quick disconnection of field cables from the System terminal boards.

V. All user-programmable data shall be stored in a non-volatile EEPROM memory to prevent memory loss during a power failure. The system time clock shall be capable of maintaining correct time for a period of 14 days in the event of a power failure. It shall be possible to return the system programming to the original factory default setting by keying a special code from the Console.

W. The user shall have the capability to change system programming for all paging functions, bell functions, and clock functions. The Owner shall be provided with the required training, documentation, and software to accomplish these functions.

X. The system shall be connected to a (owner-provided) Ethernet network port using the TCP/IP protocol. Provide patch cord of sufficient length to connect the head end equipment to the owner provided network switch in the MDF.

Y. The user-interface shall support user names and passwords. There shall be multiple levels of access allowed. Some users may have view privileges only while others may edit their site. All editing shall be by means of the Web Editor.

Z. The program shall also serve as part of the documentation process. Page Zones and bell schedules shall support user-definable names and display as pick lists when editing the configuration.

AA. Diagnostic functions shall be accomplished through any PC connected to the school network and provided with the proper authorization and diagnostic software. Any off-site PC shall have access to the system for diagnostics through the use of the public internet, provided that they have been granted proper authorization and have been provided diagnostic software.

BB. Although the system is programmed through a PC interface, the system shall not have to rely upon a personal computer for day-to-day operation. All programming information shall be loaded into the XL system allowing independent operation of the system.

CC. Provide a -1dB balanced audio line-level output from the public address system to each local sound system (listed in this specification, ie: gym, auditorium, Library Media Seminar Room, student dining, PE Alternative) and provide equipment, cabling and signals for emergency pages to over-ride the local sound systems. Coordinate with the owner prior to installation during paging zone identification.

DD. The final copy of the program and the configuration of data files shall be provided to the school in electronic format.

EE. Provide a microphones for general announcements in admin area. Unit shall be a hand-held microphone device with a table stand. Microphone shall be Shure 522 or equal. Communications subcontractor shall use XLR type connectors and West Penn 2529 cable or approved equal between the front office location and the Public Address microphone interfaces. Locate microphone and cabling at A1 faceplates in the admin area at front counter. Use open ports for cabling in A1 faceplate and terminate XLR connector to cable, not faceplate.

FF. Wire (via cabling to access control panel) panic button switches (PB symbol on drawings, provided by 28 00 00 communication subcontractor) to PA system for contact closure input. Upon contact closure, PA system shall initiate a lockdown sequence, as specified by owner. Coordinate lockdown events with owner (tone, audio message, and so forth) and provide programming to accomplish lockdown procedure.

GG. Unspecified Equipment and Material. Any item of equipment or material not specifically addressed on the Drawings or in this Document and required to provide a complete and functional installation shall be provided in a level of quality consistent with other specified items.

HH. The system shall allow a telephone to be associated directly with a loudspeaker by assigning them the same dial number.

II. LOUDSPEAKERS, BAFFLES, AND BACKBOXES

1. Speaker/Baffles: Provide backboxes to electrical subcontractor for installation.
   a. As indicated on plans (SP), provide a ceiling mounted round speaker and baffle assembly. The baffle shall be 12-7/8" in diameter and 3/8" deep. The circular design shall match the room ceiling tiles.
   b. Baffle shall be constructed of 22 gauge, cold rolled steel, coated with a baked on white powered epoxy that is resistant to scratches.
   c. Holes in the baffle shall allowing mounting to speaker backbox.
   d. Room speakers must allow hands free talk back when room is paged.
   e. Speakers must meet the following:
      1. Type: Flush mounted 8" cone
      2. Frequency Response: 50 to 18,000 Cycles
      3. Magnet: 6 oz.
      4. Axial Sensitivity 95 dB at 4 ft. with 1-watt input
      5. Telecor STB-11 Speaker/Transformer/Baffle Assembly with T8 Support Bridge and H8 Enclosure or equal.
2. Provide Volume attenuators where shown on the drawings (A symbol in a circle) to adjust the volume of the local PA speaker.
3. Horn Speakers: Indoor/Outdoor: External Building PA Speakers (as shown on technology drawings ES (recessed, enclosed), and internal PA Speakers for the Gymnasium, Auditorium, Library Media Seminar room and Student Dining (as shown on technology drawings FS and HS, recessed/flush mounted (FS) and HS surface mounted with back boxes).

   ES type:
   a. Double re-entrant type: flush mount installation.
   b. Frequency Response: 600 to 14,000 Hz.
   c. Power Handling: 15 Watts RMS, 30 Watts Peak.
   d. Variable screw taps, 25 V transformer
   e. Sound Pressure Level: 110 dB at 1 meter with 1-watt input
   f. Color: Coordinate with Architect.
   g. Atlas/Soundolier APF-15T Horn Speaker with 193-8-6 backbox (9-5/8" Sq X 6" Deep) and VP-161APF Speaker Baffle or equal.

   FS and HS type:
   a. Aluminum re-entrant type: flush mount installation, surface mount box.
   b. Frequency Response: 600 to 12kHz nominal.
   c. Power Handling: 15 Watts RMS.
   d. Variable screw taps, 70/25 V transformer (25:.48/.94/1.8/7.5/15w; 70:.9/1.8/3.8/7.5/15W)
   e. Sound Pressure Level: 105 dB at 1 meter with 1-watt input

f. Color: black in lower auditorium/stage. Paint black in any area where ceiling is black.

g. Lowell Unihorn LUH-15TI Horn Speaker with LUH-TBAR tile bridge were required (upper auditorium, student dining), and LUH-BOX where required (gym, lower auditorium).

h. Dispersion 80degrees

JJ.TELEPHONE INTERFACE

1. Communication subcontractor must provide system interface and connection to the Owner's telephone system (Provided by owner). Provide all equipment and cabling necessary to connect and integrate system to the phone system.
2. Each trunk shall be programmable as either incoming, or outgoing, or both.
3. For incoming trunks, system shall be able to direct calls to a user-defined attendant telephone or provide dial tone. For outgoing trunks, system shall provide access to the trunk by dialing 8, 9, or both. If digit 9 is used to access an outgoing trunk, the system shall be able to automatically dial a second 9.
4. Each trunk shall be loop start.
5. Communication subcontractor of this section must coordinate telephone interface with Owner.
6. The PA system shall be fully independent from the phone system but provide integration to the phone system as mentioned above.

KK. INTERFACE WITH REMOTE SOUND SYSTEMS

1. The system will interface with remote audio systems in the following locations to mute source material upon pa announcement:
   a. Both Cafés
   b. Gymnasium
   c. Auditorium
   d. Classroom auxiliary sound and voice lift systems

2.2 MASTER CLOCK AND SECONDARY CLOCK SYSTEM

A. The system shall provide "State of the Art" Technology for Master Clock and Secondary Clocks, so that they form an integrated system together and with the Public Address System. Time programming shall be accomplished by way of a microprocessor-based and user-programmable master control system. The system shall be easy to learn and operate. All standard system programming shall be user-friendly to allow the system administrator the ability to easily reprogram system features. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve. The Master Clock shall use an integrated master controller capable of operating and correcting both digital and analog secondary clocks as well as controlling class change signals to all speakers. The Master Clock systems shall provide the required signals to assure synchronization of all Secondary Clocks. Provide equipment and integration as necessary to utilize the master clock system as a network time source for the school LAN. The Master Clock System shall be by Telecor, Inc., Bogen, Sapling or equal. The master clock shall include a web interface.

B. Master Clock System shall provide the ability to:

1. Provide automatic distribution of user-programmable time signals controlled from an integrated, 24-schedule, 1,024-event time clock. Time signal programming for 16 of the 24 schedules shall be available from the Web Editor. Eight (8) of the 24 shall be available at the Control Console.

2. Provide for program override to support manual distribution of class change time signals to all areas, or select groups of speakers from the control console.

3. Transmit class change tones to selected areas of the school. Duration of the tone, as well as frequency and burst length and output level shall be software-programmable from the Control Console with 500 different combinations possible. User-programmable time

signals shall be available to any of 16 time zones independent from paging and program zones. Three separate class change tone groups are required: High School Bell schedule, Middle School Bell schedule, Pre-K bell schedule.

4. Incorporate a built-in calendar with the capability to program in all holidays, and provide for automatic clock correction for Daylight Saving Time and Leap Year changes.

5. The unit will further permit programming, diagnostic, and activity logging through connection to an external computer.

6. Provide a 10-year battery back-up real time clock.

7. Battery back-up shall be provided to the Public Address/Intercom/Clock System, ensuring correct timekeeping of the Master Clock System during power failures. Once power is restored, the Master Clock shall instantaneously update all clocks with the correct time.

8. The Master Clock shall be capable of correcting analog secondary Clocks without the need for special hardware.

9. The ability to connect through the facilities Ethernet Network to obtain time synchronization from a Time Server.

10. The system shall have the capability of providing alpha-messaging as part of the time/tone schedules. The integrated Master Clock shall provide sixteen (16) user-programmable messages which may be activated as a part of the time/tone schedules, external relay, remotely located buttons, or through the front panel of the unit.

C. The Telecor 2463-D Analog Secondary Clocks are designed for use in conjunction with Telecor's Master Clock, as well as Telecor microprocessor-base Administrative Communication Systems. When used with Telecor's C5PPL, CAT 5 Patch Panels, the clock can be installed using CAT 5 cable.

1. These Analog Secondary Clocks are synchronous 3-wire units with a second hand to mark the fractions of a minute as well as the minute and hour hands. These clocks can be powered from either a 24 VAC or 24 VDC source. Provide and install clock power supplies in the local IDFs and MDF.

2. The 2463-D Model has a 16" diameter display and is housed in a low-profile, semiflush metal case designed for wall mounting. Provide at all C16 locations on the drawings. Provide 12" analog clock, model 2461-D, where noted C12 on drawings.

3. The low profile design eliminates the need for custom backboxes and all clocks are designed to be mounted onto single gang electrical utility boxes.

4. Provide wire guards for all clocks in the gym and locker rooms. Wireguards shall be constructed of 3/32" diameter welded steel wire screen with 2" openings and 3/16" reinforced hoops. All joints are to be welded for strength and durability. The guards shall be finished in a rugged epoxy powder-coat finish, suitable for both indoor and outdoor environments.

D. The Digital Clock (provide at C symbols in a circle as shown on the drawings), shall be designed for use in conjunction with the Telecor II/XL Communication System.

11. The Digital Clock shall simultaneously display the current time. The time shall be displayed in hours, minutes and seconds. Hours and minutes shall be displayed using 4.0" digits, and seconds (if available) shall be slightly smaller for easy distinction.

12. All secondary clocks shall be continuously synchronized with the Master; corrections shall be done instantaneously and all clocks shall display the identical time and date. In the event of a power failure, the Telecor system shall maintain proper timekeeping during the outage. Once power is restored, all clocks shall be immediately updated with the correct time and date.

13. The Digital Clocks shall utilize AlGaAs “Super-Bright” LED displays which shall offer exceptional visibility characteristics and shall be viewable from up to 120 feet away.

14. The clock bezel shall be anti-glare red with a smooth surface. No external screws or studs shall be visible on the bezel or clock housing.

15. The Digital Clock shall be recessed mounted. Provide backbox at all locations to electrical subcontractor for installation.

PART 3—EXECUTION

3.1. EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means communications subcontractor accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions, the communication subcontractor shall have equipment installed on the AC voltage supply, taking care to arrest damaging electrical transients and spikes that can cause damage to the microprocessor components of the system.

B. Install clocks as specified on the drawings and elevations. Where conflict occurs, notify the architect.

C. Install classroom and hallway loudspeakers into the suspended ceiling tiles.

G. Install and wire system in accordance with manufacturer’s approved drawings and diagrams.

H. Provide and mount clock power supplies in IDF locations, and service via cable tray to classroom location. Coordinate with electrical subcontractor for all power requirements.

I. All cabling shall be installed in a neat, orderly and professional manner.

3.3 INTERFACE WITH OTHERS

A. All equipment shall be installed and connected in strict accordance with the manufacturer’s recommended instructions.

B. Provide interface with telephone system.

C. Interface remote sound systems in Gymnaisum, Auditorium, Cafes andclassrooms to provide program muting of these systems. Cordinate with 27 40 00 communication subcontractor and theater (for auditorium) subcontractor..

D. Provide interface with access control system for lockdown purposes

3.4 FIELD QUALITY CONTROL

A. Provide field inspection and testing.

B. Perform operational test on each item of equipment and on system.

3.5 MANUFACTURER'S FIELD SERVICES

A. Observe installation of communications system.

B. Provide field technician services to make final signal cable connections to equipment.

C. Prepare and start systems.

3.6 ADJUSTING

A. Adjust controls and audio levels to achieve proper operations (as per manufacturers recommendations and owner directions).

B. Set status of each classroom call-in device and other stations as indicated.

C. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory-authorized communication subcontractor for the products furnished. The communication subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

3.7 DEMONSTRATION

A. Provide systems demonstration and instructions. Provide a minimum of 10 hours for PA and master clock systems. Provide the Owner with a training program designed to make all administrative control station users familiar with the operation of the voice communications and emergency notification and response system.

B. Employ manufacturer's field representative to demonstrate system operation to designated Owner personnel.

C. Use submitted operation and maintenance manual as reference during demonstration and training.

D. Submit field reports indicating satisfactory installation and testing of system.

F. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.8 WALK THROUGH

A. Conduct walking tour of project and describe function, operation, and maintenance of components. Provide volume adjustments as necessary to provide acceptable sound levels to the Owner.

END OF SECTION

Section 27 70 00
VIDEO DISTRIBUTION SYSTEM
(FILED SUB-BID REQUIRED AS PART OF SECTION 26 00 01)

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 - General Requirements.

1. Work of this Filed Sub-Bid includes all individual specification sections listed in Section 26 00 01

1.2 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Installer”, “Contractor”, “Communications Subcontractor” and “Communications System Integrator” and “bidder” shall be used interchangeably and shall be understood to represent the bidder responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations identified in this section.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within three (3) business days.

1.3 SUMMARY

A. Furnishing of all labor, project management, materials, tools, equipment, cabling, terminations and resources necessary for the complete installation of the IPTV Video Distribution System as specified herein, and as shown on T2.7, T2.8, T2.9 and other technology drawings.

B. It is the intent of this specifications that the bidder (bidder shall provide proof that they are an authorized system installer/integrator for the manufacturer of the IPTV system) expeditiously furnishes and installs a system complete in every respect and ready to

operate. All miscellaneous items and accessories required for such installation, whether or not each such item or accessory as shown on the plans or mentioned in this specification shall be furnished and installed.

C. The Video Distribution System must consist of the following features that will be specified in detail below:

1. IPTV Video Distribution Headend
2. Analog Media Playback Devices
3. Digital Video On Demand Server
4. Encoding station to encode DVDs to the VOD server
5. RS232 Control System, providing classroom workstation control plus administrative control of RS232 LCD TVs and projectors. All inputs to the TVs, interactive flat panels and projectors shall be switchable from within the graphical user interface of the IPTV system.
6. Bulletin Board video information system with licenses for 6 streams.
7. HDMI and RS232 cabling (RS232 cable 9 conductor minimum) and terminations from STBs to the TVs and HDMI cables from STBs to the T1 faceplate and STB to classroom interactive flat panel RS-232 cabling. Audio cable from the STB to the classroom and voice lift systems. Audio and HDMI cables from STB to DSP in Floor 1 Café.
8. TVs and mounts
9. Provide cabling from 12 IRD to encoders, and cabling from CATV service demarc to CATV IRDs.
10. IPTV delivery platform must be compatible with MAC as well as PC based computer systems.
11. The system shall include emergency broadcast capabilities to enable administrators to take over viewing/channel selection, with subsequent return to individual settings.
12. It is the responsibility of the communications subcontractor of this section to coordinate cable pulls at T1 faceplate locations with 27 40 00 communications subcontractor to ensure a single cable pull is used for 274000 and 277000 cabling.
13. RG6 and RG11 as shown on IPTV drawings.
14. All interactive flat panels, projectors and TV control shall be via RS232; all RS232 cable and terminations to be provided and installed by the communications subcontractor of this section.
15. All IPTV components shall be from a single source manufacturer (MediaMaster by ETR), no off the shelf components shall be utilized in the system.
16. Panic button integration - provide and install panic button (panic buttons and outputs from access control to the IPTV rack provided and installed by 28 00 00) inputs from access control to the IPTV system, program for automatic emergency all call as directed by Owner.
17. Provide and install all Cat6A patch cords required for network connectivity of devices. Patch cords for set top boxes must be Black. All other patch cords in the head end shall be Red.

18. It is the intent of this specification that a complete and fully functional system is provided and installed. All miscellaneous items and accessories required for such installation, whether or not each such item or accessory is shown on the plans or listed in the specification, shall be furnished and installed.
19. All equipment and cabling related to the TVs and IPTV system and components shown on T2.7, T2.8 & T2.9.
20. All programming required to provide the RS232 control of the interactive flat panel displays in the classrooms (interactive flat panel displays provided and installed by 274000 subcontractor) is the responsibility of the communications subcontractor of this section. Coordinate with 274000.

D. No Ceiling spaces are air plenums. No cabling needs to be plenum rated.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. SECTION 26 00 00 – ELECTRICAL

B. SECTION 27 10 00 – STRUCTURED CABLING

C. SECTION 27 40 00 – AUDIO-VIDEO COMMUNICATIONS

D. SECTION 28 00 00 – ELECTRONIC SAFETY AND SECURITY

E. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking.

F. SECTION 01 23 00 – ALTERNATES

1.5 SYSTEM DESCRIPTION

A. Performance Requirements

1. Maintain the school's IPTV system including forward and reverse broadcasting.
    a. Forward Operations: Distribution of 11 min and 135 max incoming CATV channels on 9 digital video channels.
    b. Reverse Operations: Remote origination of video feed using a mobile encoder for multicasting via the IPTV system.
    c. Ensure overall performance of video distribution system does not interfere with CATV service provider's operations.
2. CATV service shall be connected to new head-end equipment. The Owner shall provide 12 IRD boxes from CATV service provider if required. Coordinate IRD quantities with Owner and Owner's CATV service provider. Provide splitter/amplifier/taps of appropriate type to split and amplify the CATV service providers feed as shown on the drawings.
3. Provide every required part of system complete in detail and operable in unison with all other sections of this specification, resulting in a complete IPTV video distribution system.

4. Provide all work, materials, and manner of placement in strict accordance with requirements of latest edition of National Electrical Code.

5. Provide all materials listed as complying with available standards of Underwriter's laboratories or other similarly established standards and carry their label. Apply all materials in strict accordance with Underwriter's laboratories listing.

6. All work described in this Section performed by a manufacturer certified communications subcontractor. Bidder shall provide proof of manufacturer certification.

1.6 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00 - SUBMITTAL PROCEDURES with tabulated and indexed pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:

1. Submit:

a. Product Data Sheets

b. Installation Instructions

2. Manufacturer Certificate and Certified Training Certificates of communications subcontractor who will be providing, programming and warranting the equipment.

C. Shop Drawings:

1. Submit three (3) digital copies in AutoCAD 2010 or later on a CD of shop drawings, including:

a. Layout of equipment on supplied AutoCAD drawings, include labeled wiring risers showing all equipment.

b. Rack elevation drawings

c. Equipment locations

d. Detailed wiring diagrams (as-builts) of data ports used to connect set top boxes, TVs, and projectors. Diagrams shall include VLAN identification information. Include patch panel numbers in the IDFs and MDF for ports used for projectors, TVs and set top boxes. Label all patch panel ports if not labeled, designating projectors (P), set top boxes (S) and TVs (T).

D. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit three (3) copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.
5. Estimated costs for maintenance and software assurance for the system on a yearly basis.
6. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, in the close out submittals
7. Warranty certificate with contact numbers with appropriate start and stop dates.
8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.7 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for the system, that specializes in IPTV with a minimum of five (5) years in the industry.

B. Communication Subcontractor: Company specializing in IPTV and Audio Visual Systems with a minimum of five years experience on the MediaMaster system of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project. Provide valid current proof of manufacturer's certification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials to be stored on site in their original protective containers. Clearly mark all material containers to indicate project name, number and Manufacturer's / Communications subcontractor's name.

B. Distribute any material stored in building to prevent blocking of passageways and as directed by Owner, Project Manager or Architect. Do not store material in building without Owner's prior approval.

1.9 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of thirty-six (36) months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the Owner after training before the warranty is to begin. Three (3) year warranty shall cover the complete system and all components. This shall include all software assurance for three (3) years. Warranty shall include all travel expenses.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and a help desk. Provide qualified technicians that are experts in IPTV, LAN/WAN design and support, and AV control, and who are familiar with the work at the site, within twenty-four (24) hours of receipt of a notice of malfunction, excluding weekends and holidays. Coordinate all VLAN, port and switching configurations required with the Owner (Switching equipment provided by Owner).

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within forty-eight (48) hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than ten (10) days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this thirty-six (36) month period.

H. Response Times - Normal business hours shall be 7:00 a.m. to 5:00 p.m., Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

I. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

J. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

1.10 MAINTENANCE

A. Service Calls: Provide twenty-four (24) hours of service calls on system for the school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Warranty work is not included in the service call time.

PART 2 – PRODUCTS

2.1 MEDIASERVER

A. The MediaServer shall consist of, but not be limited to, the following:

1. The MediaServer shall be located in MDF in an 84" enclosed media cabinet to keep it clean and prevent bumping and jarring. It shall feature forced-air cooling. Cooling air shall be drawn through a front cleanable filter and exhausted out of the rear of the case. The rack mount case shall be constructed to provide adequate airflow over all components. Provide and install rack where shown on the drawings.
2. The MediaServer shall minimally consist of:
    a. Minimum Intel Dual Core 3.6 GHz CPU with 8GB of ECC RAM based server unit with dual 1GB Ethernet NICs.

b. Minimum 25TB useable hard disk storage (if the Digital Video Server is included), protected by a RAID-5 array and controller with battery backup module, and RAID array with swappable drives and redundant power supplies and hot swap configured spare drive installed.

c. MPEG1&2, H.264 and HTML5 video in high resolution bit rates up to 16Mb.

d. Install all components in the MDF head end room.

e. Systems incapable of TCP/IP control will not be considered equivalent.

f. The Digital Video On Demand Server may be encompassed with the MediaServer.

g. The VOD server shall be NAS compatible to accommodate future content storage.

3. The operating system shall be Linux, a multitasking TCP/IP capable OS. It shall communicate over TCP/IP without modification. It shall be compatible with all client operating systems and software.

4. The MediaServer shall communicate with all classroom PC or Macintosh workstations simultaneously. The architecture shall be browser based. The communication link will provide teachers with schedule updates in real time as they occur. Teacher (client) login to server shall take no longer than three (3) seconds.

5. The MediaServer shall bi-directionally communicate individually or globally with Ethernet Projectors and TVs, Ethernet Tri-band Tuners, RS232 Plasma Displays, RS232 LCD Displays, RS232 TV Tuners, RS232 Projectors, Ethernet Television Control Units (ACI), RS232 Television Control Units (CCM), RS422 Television Control Units (CCM), and Ethernet Media Control Modules (ACM), via TCP/IP over a Local Area Network, Wide Area Ethernet Network, and or Internet.

6. The MediaServer must support remote maintenance and upgrades of the Server software and all other video on demand software. No system will be accepted that requires onsite service as the primary means of updating and providing software fixes and releases. The District shall grant secure firewall permissions for remote login and diagnostics of the MediaServer. The multi-tasking MediaServer must continue to operate in a fully functioning mode while remote login and diagnostics are being performed. This architecture allows accurate system diagnosis under fully “loaded” conditions via the network, or the Internet. Systems that require users to disconnect or normal functioning to cease during remote login and diagnostics shall be unacceptable.

7. The MediaServer shall be a wholly graphical based, user-friendly system for configuration and diagnostic maintenance. Systems, which use character based configuration utilities, will be unacceptable.

8. The MediaServer shall globally administrator preprogrammed/automatic TV and projector Power Down during non-authorized hours for energy and lamp conservation. After the global Power Down, TVs and or projectors may again be permitted for use during evening activities.

9. The MediaServer shall disable front panel controls on MediaMaster Network Certified TVs and or projectors. In this mode teachers and students cannot manually control TV and projector use. MediaMaster shall be the only method of local or global control. This is a mandatory feature in public or common spaces.

10. The MediaServer must constantly poll and receive current status from the networked TV displays. Systems which periodically send a power off command are not acceptable.
11. The MediaServer with shall administrator Video All Call and Video Zone Page announcements. Quantity of Video Paging Zones shall be unlimited. Configuration shall be graphically based and user-friendly. All video monitors in the School will be remotely powered on/off and controlled using this software and hardware feature. The system administrator can see in real time that displays are On, Off, Not Communicating, what input has been selected on the TV or projector, what channel a teacher is viewing, or have images from their workstation displayed.
12. The MediaServer shall include Playlist software. Playlist allows any zone of TVs and or projectors to be Powered On, tuned to a CATV channel, or play one or many MPEG titles from the Digital Video Server. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors and projectrs are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled. Typical applications include Bulletin Board, Weather Channel, News Channel broadcasts to Lobbies and Cafeterias. Daily applications such as The School's Morning News Broadcast can be pre-encoded and auto-play during the pre-scheduled Playlist event. Special events, like a digital title playing on the Cafeteria TVs and or projectors for an after-hours group between 7:00 p.m. and 8:00 p.m. can be easily accommodated.
13. The MediaServer shall automatically produce a graphically based Menu Channel, which can be broadcast over the schools IPTV distribution system. Via an asynchronous communication link, the MediaServer with Digital Video Server shall be constantly updated by teachers' using their MediaScheduler software. The MediaServer shall be supplied with a composite video output and video/audio channel modulator.
14. The operating system shall be able to support an unlimited number of TCP/IP connections.
15. The MediaServer shall include dual 1GB NIC ports. The operating system shall support multiple IP addresses simultaneously. This feature allows Intranet IP addressing to be combined with Internet IP addressing, and VLANs.
16. The MediaServer shall not use any proprietary network topology to communicate with other workstations to perform media control and/or scheduling functions. Systems that require multiple workstations to control and/or schedule media playback devices are unacceptable.
17. The MediaServer shall contain and maintain all configuration databases as well as scheduled event data. All PC and Macintosh workstations on the LAN shall have access to the MediaServer databases via MediaController, MediaScheduler, MediaAdmin as well as common FTP and Telnet connections. The MediaServer shall allow password protection at varying levels.
18. The operating system shall support a minimum of 1024 serial port connections, allowing search capability and serial control of every VCR, DVD, LDP, Macintosh and PC in the Media Center head-end. The system shall control base band video routers and/or broadband video networks.
19. The MediaServer should provide reporting capabilities on the usage of the system. The minimum reporting should be:

a. How many times is a particular video source scheduled and used.

b. How often a media title is scheduled and used.

c. How often a particular teacher uses Programming on Demand Controller.

d. What titles a particular teacher has scheduled during a specific period of time.

e. What room locations use the system most frequently.

f. Reporting shall be ad-hoc with media administrators being able to customize reports.

20. The District shall supply two 1GB data ports and static IPs, the Communications Subcontractor of this section shall supply and install two CAT6A data cables.

21. The MediaServer shall be configured for school lockdown scenarios in the following manner:

a. The server shall accept 4 contact closure inputs from the access control system (28 00 00).

b. The 28 00 00 Communications subcontractor shall provide 4 relay outputs and wire to the Communications Subcontractor of this section. Communications Subcontractor of this section shall install realy output to media server input.

c. Upon contact closure, the media server shall control all projectors and TVs in the school and present a video file (up to 5 independent video files if desired) from the VOD server as per Owner direction. Provide all programming to accomplish Owner's desired lockdown procedure/event. Size content to properly display on all projectors and TVs.

d. Provide a shortcut on the desktop of admin personnel (as determined by the Owner) to accomplish this same procedure via a desktop shotcut. Label this shortcut as per Owner direction. Provide this shortcut within a folder on the desktop to avoid accidentally initiating a lockdown.

22. Browser based MediaServer shall be the MM-3000 MediaMaster Streaming Video on Demand WebServer by ETR, or equal. It shall be rack mounted in the MDF headend. The MediaServer and Digital Video Server may be separate units, however the Digital Video Server must contain a minimum 25TB storage in the above configuration if not part of the MediaServer.

2.2 UNINTERRUPTIBLE POWER SUPPLY (UPS) – PROVIDE 1

A. Provide a full-time, perpetually on-line UPS system providing sine wave correction, voltage regulation, spike suppression, and a minimum of 20 minutes backup power. Standby UPS systems are not acceptable.

B. The UPS must be capable of interfacing to the MediaServer with Digital Video Server with an alarm function to enable an orderly shut down prior to complete loss of power.

C. One large UPS shall serve the MDF headend

D. UPS for Head End shall have a 208v30 amp twist lock plug.

E. Provide UPS systems as manufactured by Para Systems, Liebert, Sola, Tripplite, or equal.

2.3 DIGITAL VIDEO SERVER

A. The Digital Video Server shall consist of, but not be limited to, the following:

1. Central video service will be provided via an MPEG1, 2, H.264, HTML5 multicast based Video on Demand Digital Video Server. In addition to the Video on Demand file server with mass storage, the system shall support an analog to digital encoding/DV encoding system.
2. The Video on Demand Digital Video Server unit will provide playback of motion video sources. The server shall transcode and store motion video signals in MPEG1, 2, H.264, HTML5 multicast formats on multiple redundant hard drives and deliver video via the School's IGMP enabled network to PCs and MACs, and to TVs and projectors with decoders that convert the MPEG signal into an HDMI digital audio/video signal. The unit will consist of one integrated server. Video-on-Demand Digital Video Server:
    a. Minimum Intel 64 bit QuadCore based server unit with dual 1GB Ethernet NICs.
    b. Content shall be protected by a RAID-5 array and controller.
    c. District owned content shall reside on multiple hot swappable hard drives with 25TB minimum capacity. Operating system shall reside on independent 1TB drive.
    d. MPEG1&2 video in high resolution bit rates up to 20Mb 1920 x 1080 resolution with 30 FPS each.
    e. Redundant power supplies shall be provided.
    f. Install all components in locking cabinet in the head end room.
    g. Systems incapable of TCP/IP control will not be considered equivalent.
    h. The Digital Video On Demand Server may be encompassed within the MediaServer.
3. The DVS shall be capable of delivering unlimited Multicast digital video streams over the School's network. VLC Player with MPEG decoder is supported for teacher playback. The District will provide adequate and prioritized bandwidth for this application.
4. For RF applications the Video on Demand Server shall allow every teacher to uniquely Bookmark any District owned video. A Jump To button shall be included, and when selected shall trigger an instant viewing of a scene essential to the teacher's lesson.
5. The District shall supply two 1GB data ports configured for IGMP Snooping and 2 static IPs. The communications subcontractor shall supply and install CAT6A data cables.
6. The MM-3000 MediaMaster Streaming Video WebServer shall be by ETR, or equal.

2.4 NETWORKED DIGITAL VIDEO RECORDER SERVER

A. The Digital Video Recorder Server shall consist of, but not be limited to, the following:

1. The NVR is an integrated package allowing the School to manually or automatically encode video from tapes, discs, CATV, Live Encoders, and Bulletin Boards onto the Digital Video on Demand Server with automatic Title Database Update. The system includes the following components and capacities:

    a. At a minimum: Case shall be full format to permit full size PCI and PCIE cards, and 2 memory slots. System Processor shall be Intel Core2Duo 3.4GHz. Memory shall be 1.0 GB, 800 MHz DDR2. Hard drive shall be 3TB SATA, 3.0GB/S. Mouse shall be optical with USB connector. Integrated 1GB NIC Port.

    b. Operating system shall be Linux preloaded. No free trial software shall be loaded.

    c. Hardware and MediaRecorder software to transfer encoded files to the Digital Video Server, and simultaneously transfer metadata to the Title Database for search and immediate on

    d. Ability to preview and cue the video and audio source.

    e. The intuitive encoding process shall not require a full time attendant, and be available to any User with MediaRecorder Administrative Rights.

    f. A Web based TV Guide shall be included.

    g. Encoding format shall be H.264 HD Transport Stream to allow any video to be multicast to every TV and projector simultaneously.

    h. The District requires the ability to immediately encode, or preschedule online encoding of 24 simultaneous CATV, DVD, VHS, or Live Multicasts broadcasts during school hours, evenings, and or weekends. Every stream shall simultaneously be viewable by teachers and administrators during the encode process, without interruption.

    i. Install the preconfigured NVR in the MDF headend. The District will supply network settings.

    j. Networked Digital Video Recorder Server shall be provided and installed if the network video recording functionality is not software based within the Media Server specified in article 2.1 or the Digital Video Server specified in article 2.3.

B. The District shall supply a 1000MB data port configured for DHCP and IGMP Snooping. The communications subcontractor shall supply and install a CAT6A patch cable.

C. The Networked Digital Video Recorder with all peripherals shall be the MediaMaster MM-1138 MediaRecorder by ETR, or equal.

2.5 HIGH DEFINITION PRESTO VIDEO BULLETIN BOARD PC (Provide 1 with 6 licenses.)

A. The Bulletin Board shall be preloaded with PrestoVideo PowerPoint to H.264TS Transcoding software with the capability for up to 24 simultaneous transcodes, file loads, or transfers. The Bulletin Board is an automated high definition visual message package allowing the School to create and display important information for staff, students, and community. At a minimum the system includes the following components and capacities:

1. Rack mounted case shall be full format to permit full size PCI and PCIE cards, and 2 memory slots.

2. System Processor shall be Intel Core7 3.2GHz.

3. Memory shall be 4.0 GB, 800 MHz DDR2.
4. Hard drive shall be 3 TB SATA, 3.0GB/S.
5. 2 Front and 4 rear USB connectors.
6. Supports PS2 or USB mouse and keyboards.
7. DVD reader shall be 16X. Integrated 10/100MB NIC Port.
8. A full size Composite Video and S-Video Out card shall be installed and preconfigured.
9. HDMI, VGA, and Composite Out shall be included.
10. Operating system shall be Microsoft Windows 8 preloaded.
11. Graphics software shall be Windows PowerPoint preloaded.
12. No free trial software shall be loaded.
13. Full 1080p output.

B. The Bulletin Board shall be configured for password protected remote access by department personnel that need to display information: HS, MS, Pre-K Administration, Athletics, Arts, Food Service.

C. The Bulletin Board shall be preloaded with PrestoVideo PowerPoint to H.264TS Transcoding software licensed for 24 simultaneous transcodes, file loads, or transfers. Transcode shall take no longer than the duration of the PowerPoint. Real time status shall be provided. PrestoVideo shall automatically transfer presentation file metadata to the VOD Server Title Database upon completion of the transcode process.

D. The Bulletin Board shall operate in concert with MediaMaster Playlist. Playlist allows the Video On Demand System to function as an automated broadcast system. Any zone of TVs and or projectors may be Powered ON, tuned to the Bulletin Board Channel. The quantity of TVs and or projectors in any Playlist Zone is unlimited. Playlist shall control zones of TV and projectors intuitively organized by columns and rows and selected by check box.

E. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled.

F. The Playlist shall have the ability to Power On all TVs and projectors and display the Bulletin Board every morning during homeroom. Students in Visual Communications Program shall have the ability to switch all TVs and Projectors from the Bulletin Board Channel to the TV Studio Channel when they are ready to broadcast.

G. The Bulletin Board shall output all presentation streams in 1080p high definition.

H. The HDMI port shall be connected to the rack mounted PC/TV monitor.

I. The District shall supply a 1000MB data port configured for DHCP and IGMP Snooping. The communications subcontractor shall supply and install a CAT6A patch cable.

J. The 6 Bulletin Board licenses with all peripherals shall be the MediaMaster MM-8100PV PrestoVideo Bulletin Board by ETR, or equal.

2.6 MEDIASERVER ADMINISTRATOR SOFTWARE

A. The MediaServer Administrator software shall consist of, but not be limited to, the following:

1. The MediaServer Administrator software shall provide a graphical representation of all administrator functions required by the Video On Demand system.
2. The MediaServer Administrator software shall provide password-protected access to the administrator functions. Only personnel with administrative permissions can access this software.
3. The MediaServer Administrator software shall be Web based.
4. The MediaServer Administrator shall provide for the following administrative functions:
    a. Adding, deleting, and editing User information.
    b. Adding, deleting, and editing media Title information.
    c. Adding, deleting, and editing scheduled Event information.
    d. Adding, deleting, and editing Room information.
    e. Adding, deleting, and editing Source information.
    f. Adding, deleting, and editing TV and projector control configurations.
    g. Logging projector lamp usage and printing reports.
    h. Logging video usage and printing reports.
    i. Logging projector and TV IP addresses, manufacturer, model number, and printing reports.
    j. Automated shutdown of every TV and projector for daily energy conservation or a lock down.
    k. Automated power on and shutdown of every TV and projector for zone or all global pages.
    l. Manual override & shutdown of every TV and projector for a lock down.
    m. Manual power on and shutdown of every TV and projector for zone or all global pages.

B. The MediaServer Administrator software shall provide Zone Page functions. Zone paging is defined as the ability for media administrators to selectively power on and off TVs and or projectors in the LAN, WAN, MAN, and Internet environment. The Zone Paging function shall have the following minimum functions:

1. Create and edit an unlimited amount of zones.
2. Display the current status of every TV in every zone. MediaServer Administrator software shall poll and receive status from the networked TVs and or projectors. The software will then display a Gray TV for Off, a Blue TV if On, and a Red TV if there is a problem. It shall also display what input or channel is being viewed in every room.

3. For every projector the Zone screen shall show accrued lamp and filter usage to allow proactive maintenance. Lamp status is imperative for yearly maintenance budgeting.
4. Allow individual control of any classroom TV with the MediaServer Administrator software. This includes Power, Volume, Channel, Mute and Input source control.
5. The software shall be capable of manually selecting any zone, selecting a channel for the video zone page, and powering TVs and or projectors on for the duration of the broadcast. TVs and or projectors that were off prior to the video page will power off following the page. TVs and or projectors that were on prior to the page will remain powered on and return to original channel or input previously viewed.
6. Using the MediaServer Playlist software, the system shall be capable of prescheduling Zone Pages. This function shall include scheduling TVs and or projectors to power on and off, selecting the appropriate channel for the TVs and or projectors in that zone, and scheduling videos to automatically play. TVs and or projectors that were off prior to the prescheduled video page will power off following the page. TVs and or projectors that were powered on prior to the prescheduled video page will remain on and return to original channel being viewed.
7. The MediaServer Administrator software, in conjunction with the ACI, shall be capable of displaying the status of a motion detector (PIR) from the ACI. The Programming on demand Administrator software shall then be capable of sending a message to an addressable security system that motion in that room location was detected.
8. Located under the System tab, the Load Marc Records field allows the user to Import MARC 21 library format files from most library systems. The Load function allows the user to add to the end of the title database or to overwrite the existing title database.
9. Located under the Period tab, the MediaServer Administrator provides the ability to define the beginning and end of an unlimited quantity of school periods. Defining periods allows teachers using MediaScheduler to schedule by period. Or, the School may prefer to schedule by time, which the system also allows.
10. Located under the Channels tab, the MediaServer Administrator provides the ability to build a complete channel lineup. Only the preferred channels are identified, assigned a channel number, assigned a channel icon from a built in database of national logos and or downloaded from a remote database. Once the Channel is fully defined, MediaController users simply point and click on the History Channel icon and the TV tunes to the appropriate channel. Teachers who reside outside the School's local CATV service provider's franchise need not be familiar with the numerical channel lineup, they simply click the familiar icon of the channel they desire. Systems without icon based channel control require additional teacher training and are therefore deemed inferior. Software based Channel configuration is a mandatory requirement to allow cherry picking available channels on a temporary or permanent basis without using expensive RF filters or processor hardware.
11. The MediaServer shall include MyChannel software. MyChannel shall administer the configuration, management, exclusion, and monitoring of CATV and in-house broadcast channels. It shall include a database of full color bitmaps of all of the School's currently available broadcaster logos and allow easy import of new bitmaps as new stations come online. This feature allows the District to create pages of available and authorized channels. It shall not be necessary for teachers

to know the CATV channel number, they shall simply select the bitmap logo of the broadcaster they desire. If the teacher wants to stream the channel or broadcast to their desktop or laptop computer, the MediaServer will automatically open a software player/decoder and play the stream. If the teacher wants to stream the channel or broadcast to their projector or TV, the MediaServer will automatically command the MM-1274T hardware to decode the stream, power the projector or TV On, then switch input to HDMI, component, or VGA to view the stream. MyChannel shall work in concert with the MM-1210 ACM.

12. Located under the Sessions tab, the MediaServer Administrator provides the ability to view all users logged into MediaMaster. The Administrator can view a snapshot of what every teacher is doing and can log any user off the system if required.

C. Located under the Sources tab, the MediaServer Administrator provides the ability to define what analog and digital playback sources teachers can control via MediaController. Buttons can be added or deleted based on capability of the playback source, or by what permissions the School allows. For example - A DVD power button would allow teachers to power down the DVD player and cause conflict with the next scheduled teacher. Thus, the Power button is simply not enabled on the Source Control palate. Another example - Record is a capability of VCRs, but if added and selected by a teacher, he/she could accidentally erase a tape.

1. MediaServer Administrator also allows configuration of DVD players for Advanced DVD Control. Newer DVDs now feature chapter, frame, language, menu, etc. selections. Systems without Advanced DVD Control preclude teachers from using many educational DVDs that are now provided with Laser Disk like features, and are therefore deemed inferior.
2. Located under the System tab, the MediaServer Administrator provides the ability to force TVs and projectors off at a predefined time, and keep them off. This feature is primarily used for energy conservation and prolonging projector lamp and TV life, but also serves to prevent evening occupants from watching TV for non-educational purposes.
3. The user-friendly MediaServer Administrative browser software shall be the MM-1185 MediaMaster Administrator product by ETR, or equal.

2.7 MEDIA PLAYLIST BROWSER SOFTWARE

A. The Media Playlist Browser Software shall consist of, but not be limited to the following:

1. Playlist allows the Video On Demand System to function as an automated broadcast system. Any zone of TVs and or projectors to be Powered ON, tuned to a Bulletin Board or CATV channel, or play an MPEG title from the Digital Video Server. The quantity of zones shall be infinite. The quantity of TVs and or projectors in any zones is unlimited. New Zones are easily created, and TVs and or projectors are added by simply selecting them via checkbox.
2. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled.
3. Typical daily Playlist events include Bulletin Board, Weather Channel, News Channel broadcasts to Lobbies, Cafeterias, and other common spaces. Recurring

events such as The School's Morning News Broadcast can be pre-encoded and auto-play during the pre-scheduled Playlist event.

4. Special events such as playing a requested digital title on specific TVs and or projectors at specified times can be easily accommodated without media personnel present. Multiple titles can be stacked in a Playlist to allow continuous broadcasting.
5. The Media Playlist Browser software shall provide password-protected access to the administrator functions. Only personnel with administrative permissions can access this software.
6. The Media Playlist Browser software shall NOT require additional browsers or interpreters to be installed as a prerequisite for operation.
7. The Media Playlist Browser software shall use asynchronous messaging and must graphically display system changes as they occur. Systems, which periodically poll for system update and status information, are not acceptable.
8. The Media Playlist Browser software shall support access to other Media Title Databases available on the LAN, the WAN or via the Internet.
9. The media playlist creations browser software shall be the MediaMaster MM-1160 Playlist by ETR, or equal.

2.8 MEDIACONTROLLER BROWSER SOFTWARE

A. The MediaController Browser software shall consist of, but not be limited to the following:

1. The user-friendly MediaController Browser software shall provide a graphical representation of all digital, analog, CATV, Bulletin Boards, and local origination broadcast resources to an instructor on one or many PCs and Macs in the classroom.
2. The MediaController Browser software shall communicate with all other components in the system via TCP/IP over the LAN and WAN.
3. The MediaController Browser software shall provide password-protected access to the administrator functions. Only personnel with teacher or administrative permissions can access this software.
4. The MediaController Browser software shall not require additional browsers, plug ins, or interpreters to be installed as a prerequisite for operation.
5. The MediaController Browser software shall use asynchronous messaging and must graphically display system changes as they occur. For example: Ms Smith in room 100 is logged in to the Controller screen and would like to use a VCR. While she is deciding Mr. Jones logs in as room 102 and selects VCR2 for use. Ms. Smith immediately sees an in-use "sticky note" placed on VCR2. The sticky note also informs Ms. Smith that it was Mr. Jones who selected the VCR for use.
6. The MediaController Browser software shall provide graphical icons for every cable TV channels, and in house broadcast channels available to the instructor.
7. The MediaController Browser software shall control all video monitor functions such as Power On/Off, Volume Up/Down, Mute, Channel Up/Down, PC, TV Tuner, VGA2, HDMI, and Local Video inputs.

8. Upon logging in to the MediaController Browser software, the instructor shall be given immediate control of all sources scheduled for the current time period.
9. The MediaServer Administrator software shall provide a graphical representation of all administrator functions required by the Video On Demand system.
10. The media control browser software shall be the MM-1150 MediaMaster MediaController by ETR, or equal.

2.9 MEDIASCHEDULER BROWSER SOFTWARE

A. The MediaScheduler Browser software shall consist of, but not be limited to, the following:

1. The MediaScheduler Browser software shall provide a graphical representation of all digital and analog media resources to an instructor on one or many PCs and Macs in the classroom.
2. The MediaScheduler Browser software shall communicate with all other components in the system via TCP/IP over the LAN or WAN.
3. The MediaScheduler Browser software shall provide password-protected access to all media resources. Only personnel with teacher or administrative permissions can access this software.
4. The MediaScheduler Browser software shall NOT require additional browsers, plug ins, or interpreters to be installed as a prerequisite for operation.
5. The MediaScheduler Browser software shall use asynchronous messaging and must graphically display system changes as they occur. For example: Ms. Smith in Room 100 is logged in to the Scheduler screen and would like to schedule a Title from the Title database. While she is deciding Mr. Jones logs in as Room 102 and schedules the same title. Ms. Smith immediately sees a graphical representation of when and where Mr. Jones has scheduled the title.
6. Systems that periodically poll for system update and status information are not acceptable.
7. The MediaScheduler Browser software shall support access to other Media Title Databases available on the LAN, the WAN or via the Internet.
8. The media scheduling browser software shall be the MM-1155 MediaMaster MediaScheduler by ETR, or equal.

2.10 MEDIA MENU CHANNEL

A. The independent Media Menu channel shall be continuously broadcast School wide via the video distribution system to provide teachers and students accurate information about video broadcasts. The scrolling menu channel is a NTSC representation of the most current video schedule.

B. The graphically based Media Menu channel shall be automatically produced by the MediaServer and shall not require human intervention.

C. A Media Menu channel icon shall appear on every client copy of MediaController Browser software. When the teacher selects the menu channel bitmap, the encoder switches to the stream.

D. The automatically produced menu channel shall be the MediaMaster MM-1020 MenuChannel software and hardware product by ETR, or equal.

2.11 ADDRESSABLE MEDIA CONTROL MODULE (ACM) & MYCHANNEL

A. The ACM allows global control of multiple video playback source sites in an individual school, or as a district wide WAN Video-on-Demand system without adding or maintaining multiple servers. The ACM shall consist of, but not be limited to the following:

1. The ACM shall have eight (8) Infrared output ports for controlling video playback devices such as VCRs, DVDs, LDPs, CATV STBs, DirecTV receivers, etc.
2. The ACM shall control infrared players and receivers via infrared emitter cables. Emitter cables shall be 10' long with 3.5mm mini jacks. Each emitter shall be affixed over each player's or receiver's IR receiver via self-adhesive tape, then covered with the included IR mask for additional protection and adhesion.
3. The ACM shall be locatable anywhere on the WAN/LAN. The ACM shall function as an Ethernet Network Interface Card (NIC) allowing local and remote control of infrared video playback sources. Each ACM shall have a unique IP address for identity on the network.
4. The communication protocol between the ACM and Video On Demand Server shall be TCP/IP.
5. The ACM shall have a standard 10BaseT connector for connectivity to the LAN/WAN. The 10BaseT connector shall have a Link status light and a Transmit Data light.
6. Each ACM shall have the inherent ability to learn IR control commands or accept downloaded command sets. Devices or systems that require a separate or master IR learner box or similar device are unacceptable.
7. The ACM shall have an RS-232 port which can be used for local control, local diagnostics, local IR learning, and local monitoring.
8. The ACM shall include graphical Windows based configuration and diagnostic utility software. Systems, which use character based configuration utilities, will be unacceptable.
9. The ACM microprocessor, real time clock and battery shall be self-contained on a 72 pin SIMM for quick and simple field servicing.
10. The ACM TCP/IP protocol stack shall support standard network diagnostic functions such as PING.
11. The ACM IP address shall be assigned from the MediaServer. Systems which use a dedicated device name, as an addressing scheme shall be unacceptable.

B. This project provides the School with twelve 1080p clear QAM 60fps tuner/encoders for CATV distribution. A substantial portion of network bandwidth will be dedicated for IPTV and VOD requirements. But the School's CATV provider provides more channels than there are encoders and bandwidth to transport them. MediaMaster MyChannel

shall automatically and dynamically tune channels to serve teacher requests for CATV channels on demand.

C. MyChannel is an essential MediaMaster software feature that integrates MM-1210 ACM Ethernet to infrared controllers to CATV IRDs via MM-1202 IR Emitters. This integration maximizes access to multicasts by efficiently managing teacher requests and balancing them against available hardware and bandwidth.

D. All teachers may easily select channels via their Web based MediaController GUI. If the system is serving 9 unique and simultaneous CATV channel requests it will then display a There Are No Available Tuners At This Time, Please Try Again Later message. Once any channel is no longer being viewed MyChannel frees up that hardware to serve the next teacher requesting a different channel.

E. MyChannel can store thousands of broadcaster logos in a selectable menu in M/Administrator/Channels. This Integrator shall pre-load the full color bitmaps of every broadcaster logo available from Abington High School's CATV provider. Channel lineups from all service providers are constantly changing. MyChannel shall allow the school to easily load new broadcaster logos as they change or as new ones are established.

F. MyChannel will allow the system administrator to add CATV IRDs, DirecTV receivers, Dish Network receivers, Free Over The Air Digital STBs, SD encoders, HD encoders; and provide management of these additional video on demand components without the purchase of additional software or licenses.

G. The District shall supply a 10MB data port, the communications subcontractor shall supply and install a CAT6A data cable and static IP address.

H. The IP addressable media control module shall be the MediaMaster MM-1210 ACM by ETR, or equal.

2.12 HD BLADE ENCODER SYSTEM

A. Provide a flexible, configurable, reliable, and fault tolerant multicast encoder system for 24 hours x 365 days per year operation.

B. The system shall be rack mounted in the top of the IPTV & VOD headend equipment cabinet. Encoder blades shall be hot swappable and slide into a 17 slot chassis with dual redundant hot swappable power supplies. All unused openings shall be covered with SB1 or SB2 blank plates.

C. Blades shall be available in MPEG-2 SD, H.264 SD, and H.264 HD with HDMI connectors and H.264 HD with HDMI & RGB connectors. The system shall support a mix of blade types without conflict. The system shall allow the System Administrator to easily reprogram IP addresses, Netmask, Gateway, Multicast Stream Address, Encode Bitrates, Audio Quality, Frame Rates.

D. All HD blades shall be 1080p licensed. They shall feature upgradeable resolution licensing which can be remotely upgraded by loading a license key.

E. Provide twelve (12) high definition encoders. H.264 encoders for the CATV STBs (CATV STBs provided by Owner). HD encoders shall be the MediaMaster MM-1288H4

1 Channel H.264 HDMI Encoder Blade or equal. Provide each with a 1080p license key preloaded.

F. The 17 slot encoder chassis with hot swappable redundant power supplies shall be the MediaMaster MM-1287 17 Channel MPEG Encoder Chassis.

G. Provide two (2) high definition H.264 encoders with power supply for portable recording purposes anywhere in the school; MediaMaster MM-1288H4C HDMI & RGB Single Channel H.264 Encoder with MM-1282 chassis and power supply and 1080p license.

2.13 MDF HEADEND

A. Provide 84" fully enclosed cabinets with locking rear door, removable side panels, rack mounted VOD content server, rack mounted VOD control server, 1 rack mounted bulletin board server, CATV receivers on shelves, Ethernet to IR controllers, blade encoder and chassis system, amplifiers, splitters, power strips with 10% spare receptacles, full time UPSs, and all miscellaneous components required for a complete IPTV VOD system. Assembly shall be designed to allow heat to rise without obstruction and not overheat sensitive components. Warmest components shall occupy the upper rack spaces. All unused spaces shall be filled with blank panels.

B. The entire MDF headend must be engineered, factory built, tested, certified, and crated by the manufacturer prior to shipment. Engineering schematics must be submitted for approval then again as closeout documentation.

C. Every component and the entire MDF headend assembly shall be fully compatible with the MediaMaster VOD and IPTV Web control software specified by this section.

2.14 MY CHANNEL ON DEMAND - 1080p HD SYSTEM FOR CATV

A. Communications subcontractor shall be the District's liaison to coordinate free CATV service with a flat, unsloped, strong +25dB signal strength @ CH2 and +25 dB signal strength @ CH70. Maintain, extend, modify, and connect the School's CATV system to serve the new IPTV & VOD headend. Provide shelves and mounting components in the headend cabinets, on the wall, and throughout the building as required. The IPTV & VOD headend is the preferred CATV demarcation location.

B. The local CATV service provider will supply the School a free lineup of educational channels in digital formats and various frequency ranges. Communications subcontractor will supply 12 integrated receiver/encoders to allow 12 unique and simultaneous on demand CATV multicast streams. Provide shelves and mounting components in the headend cabinets. System shall be modular to allow expansion. Communications subcontractor shall pay HD STB lease and setup fees to CATV provider for basic and enhanced basic service from start of construction until acceptance, then until the conclusion of warranty.

C. Provide MediaMaster MyChannel Ethernet Control & Management System for CATV HD tuners. System shall allow teachers to select 12 unique channels for simultaneous manual or prescheduled encoding via MediaRecorder software.

D. Provide MediaMaster MyChannel CATV on Demand software on the MediaMaster MM-3000 MediaServer to allow teachers using MediaMaster MM-1150 MediaController to select channels on a first come first serve basis. The first twelve teachers at any given

moment that select a CATV channel will take control of the tuners, the tenth teacher will be asked to try again when resources are available. Regardless if receiver control is available or busy every teacher in the building may view any of these nine CATV channel streams.

E. Provide all work, materials, grounding, and manner of placement in strict accordance with requirements of latest edition of National Electrical Code.

F. Provide all materials listed as complying with available standards of Underwriter's laboratories or other similarly established standards and carry their label. Apply all materials in strict accordance with Underwriter's laboratories listing.

G. CATV streaming may be expanded at any time by adding receivers, shelves, splitters, cabling, encoders, etc. Systems that require additional licenses or software fees for this expansion are not acceptable.

H. System shall allow any or all channels to be enabled or disabled quickly and effortlessly. When channel(s) is disabled there shall be no way to circumvent the system. When channel is enabled it shall be available at every TV & projector via decoder/display controller, and every computer with MPEG Player.

I. Channels must be streamed via HD multicast encoders on the LAN/WAN. Bit rate shall be variable from 4 Mbps to 20Mbps. Streaming via the Web is not acceptable. Channel streams shall be viewable on computers with MPEG Players, and on projectors & TV with HD decoders.

J. System shall allow channels to be “pushed” & multicasted to any or all TVs & projectors manually via MediaAdministrator/Zone Page, or automatically via prescheduled Playlist. When pushed TVs & Projectors shall Power On, switch input, adjust volume, decode and display required channel.

K. The complete CATV on demand system and all peripherals shall be the MediaMaster MyChannel CATV on Demand System product as by ETR, or equal.

2.15 LOCAL ORIGINATION MULTICASTING

A. MMAdministrator/Zones shall allow broadcast personnel to quickly configure an All Page Zone or Specific Page Zones to receive broadcasts, by simply selecting TVs and projectors via checkboxes.

B. MediaController shall be used to view IPTV multicasts on PCs or MACs equipped with MPEG-2 players. Selecting the broadcast icon will trigger the player to open and decode the multicast stream.

C. Activation of a Video Page shall automatically disrupt and page all in progress IPTV viewing on PC devices, TV and projectors with tuner/decoders from current activities, deliver the broadcast, then restore the system to its original configuration following the Video Page.

D. Activation of a Video All-Page Broadcast shall initiate a Power On command to any TV or projector that is Powered Off, all video sources in use will Pause, and all TVs and projectors will tune to the School’s local origination broadcast channel automatically.

E. Upon completion (deactivation) of the Video All-Page, all TVs and projectors will resume their previous status and sources will stay in pause mode until the teacher or student is ready to resume its use.

F. All local origination broadcast equipment shall include all cables and appurtenances required for a turn key system.

G. The video page zone configurator and TV/projector controller is part of the MediaMaster MM-1185 MM Administrator (specified previously).

H. The IPTV controller for PCs and MACs is part of the MediaMaster MediaController (specified previously).

2.16 HIGH DEFINITION MPEG DECODERS AND TVS (127 TOTAL)

A. Provide and install HDMI and RS232 cabling and terminations from STBs to the T1 faceplate HDMI jack and grommet (grommet at T1 for RS232 pass thru to the interactive flat panels), at projectors and TVs as specified. Provide and install Cat6a patch cords (black) from all STBs to data ports.

1. Provide and install 105 MM-1276 set top boxes at interactive flat panel rooms. Install in the T1 cabinet. Provide and install 6' HDMI cable to the T1 faceplate, 6' audio cable to the voice lift system, black Cat6A patch cord to the black jack in the T1 faceplate, and RS232 cable thru the grommet to the projector location. RS232 terminations by communications subcontractor of this section. Ensure de-embedded audio output is available on the set top box, for the voice lift system, or provide the model that provides the de-embedded audio required.
2. Provide and install 1 MM-1276 set top box in floor 1 café sound rack location for the café projector. Connect de-embedded audio to the sound rack DSP. Connect to data jack in sound closet.
3. Provide and install 2 MM-1276 STBs, both in the video wall cabinet in the library Connect as inputs to the video wall equipment. Provide black Cat6A jacks to the nearest black colored data port for both STBs.
4. Provide and install 1 MM-1276 in the auditorium for the projector. Provide black Cat6A patch cord to black data jack. Provide 1 MM-1276 in TV control room. Provide 6' HDMI, 10' black cat6a patch cord and 6' audio cable.
5. Provide and install 18 MM-1276 STBs at the following TV locations. Provide and install HDMI, RS232 and black Cat6A patch cord at each location: One 46" TV at Nurse suite, 200; Twelve (12) 65" TVs in hallways (3 per main curved hall as shown on the drawings, 3 total per floor); two (2) 65" TVs in Health room L04; two (2) 84" TVs in library 100A; one 90" TV at ST9-1.
6. Provide and install appropriate wall mounts for all TVs.

B. All TVs provided shall be high definition LCD TVs and with advanced features that include but are not limited to: 1920x1080 pixel resolution, 50:000 dynamic contrast ratio, minimum 160 degree viewing, RGB/PC input, NTSC & Clear QAM tuner, 1080p HDMI/DVI interface with HDCP Digital Content Protection System, high definition (HD) component video inputs, front firing speakers, built-in audio amplifiers, side mounted AV input panel, automatic signal enhancement, firmware modified for front panel lockout, 60,000 hour life expectancy, three year warranty, Energy Star Compliant,

MediaMaster Network Certified for RS232 control and status. TVs must have a minimum of 3 HDMI inputs and RS232 control port.

C. Provide and install wall mount tilting brackets listed above with all mounting hardware for walls. Brackets shall feature security hardware to prevent TV removal without the use of proprietary tools. Supply 2 security hardware tools to the school at the close of the project. Provide and install as appropriate for size of TV.

D. The MediaServer shall lock out all front panel controls on TVs installed in public spaces and classrooms to avoid building occupants selecting channels or media other than what the Administration wants viewed. Systems and components without this lockout feature are not acceptable.

E. TVs in public spaces shall not allow local control; they shall strictly perform as directed by Media Playlist to achieve automated broadcasting results such as Bulletin Board messaging.

2.17 MEDIA DELIVERY NETWORK

A. If the Communications Subcontractor's IPTV system cannot function on the School's network without modification, (except for network electronics configuration) then the Communications Subcontractor shall provide an independent communication and control network for the building. The Communications Subcontractor installation shall be "turn key" in every respect. The communication and control network must be submitted and approved.

B. The system shall allow local origination video/audio multicasting from every room.

C. All video on demand equipment shall be located in rack mounted equipment cabinets. Equipment cabinets shall be easily accessible for routine maintenance as per NEC. Provide custom-made rack panels for all video components and blank panels for all unused rack spaces. Amplifiers, encoders, processors, and other components that generate heat shall be mounted high in the cabinets to reduce radiation to heat sensitive components and media. Provide ventilation as per Manufacturers requirements.

D. The Communications Subcontractor shall provide all MediaServers, software, menu channels, video playback sources, scan converters, racks, shelves, cables, processors, combiners, amplifiers, fiber converters, media converters, and concentrators to provide a "turn key" IPTV video on demand system installation.

2.18 RG CABLING, SEE DRAWINGS

A. RG11, 75 Ohm Solid 14AWG Video Distribution Riser Cable, See T2.7

1. The coaxial cable must be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a solid 14 AWG bare copper conductor insulated with gas injected foam high density polyethylene, surrounded by a Polyethylene jacket. Cable shall be RG/11/u
3. Cable shall have a bare copper braid shield (97% coverage).

4. The cables shall meet or exceed the following standards:
   a. EU CE Mark
   b. National Electric Code- CATV or CM Rating
   c. UL-1581 Flame Test Rating
   d. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Conductor diameter: 0.064”
   b. Impedance: 75 Ohms
   c. Attenuation, Max:

1 MHZ- 0.2 DB/100’	10MHZ- 0.4 DB/100’
50MHZ- 0.9 DB/100’	100MHZ- 1.3 DB/100’
200MHZ- 1.9 DB/100’	400MHZ- 2.9 DB/100’
700MHZ- 4.1 DB/100’	900MHZ- 4.8 DB/100’
1000MHZ- 5.2 DB/100’	

   d. Structural Return Loss- 5-450MHZ, 23DB
   e. Maximum Operating Voltage- 600v RMS
   f. Normal Conductor DC Resistance @ 20deg C- 2.6 Ohms / 1000’
   g. Normal Shield DC Resistance @ 20deg C- 1.1 Ohms / 1000’
6. Provide as shown on T2.6 from MDF to TV Head End and as shown on T2.7.
7. The cable is Belden wire and cable, model 8213 or equal.

B. RG6 CABLING, SEE DRAWING T2.7

1. The coaxial cable be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a solid 18-gauge bare copper covered steel conductor insulated with gas injected foam polyethylene, surrounded by a Polyvinyl chloride jacket. Cable shall be RG/6.
3. Cable shall have a bonded aluminum foil polyester tape aluminum shield plus aluminum braid shield with 90% shield coverage plus bonded aluminum foil shield with shorting fold.
4. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory- CATV or CM Rating
   b. National Electric Code- CATV or CM Rating
   c. UL-1581 Flame Test Rating
   d. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Impedance- 75 +/- 3 Ohms
   b. Attenuations Max:

5 MHZ- 0.67 DB/100’	55MHZ- 1.60 DB/100’

211MHZ- 2.87 DB/100' 270MHZ- 3.24 DB/100'
300MHZ- 3.43 DB/100' 350MHZ- 3.72 DB/100'
400MHZ- 4.00 DB/100' 450MHZ- 4.26 DB/100'
550MHZ- 4.71 DB/100' 750MHZ- 5.59 DB/100'
870MHZ- 6.00 DB/100' 1000MHZ- 6.54 DB/100'

c. Structural Return Loss- 5-1000MHZ, 20DB Min

d. Maximum Operating Voltage- 350v RMS

e. Normal Conductor DC Resistance @ 20deg C- 28.00 Ohms / 1000'

f. Normal Shield DC Resistance @ 20deg C- 3.7 Ohms / 1000'

6. The recommended cable is Belden Wire and Cable, Series 6 CATV, Model #1621A

2.19 DIGITAL VIDEO ENCODING STATION

A. The DVES is an integrated package allowing the Schools to manually encode video from tapes and discs, and manually or automatically from analog or digital CATV channels onto the Digital Video on Demand Server. The system includes the following components and capacities:

1. Video encoding card with integral TV/Cable card tuner, providing the ability to record live broadcasts and auto record television or CATV programming. Encodes analog video to MPEG-2. Encoded video data rates of 1.5MB/s to 15 MB/s
2. Dual Layer DVD Writer
3. 4 channel video switch
4. DVD player
5. S-VHS player
6. Gigabit Ethernet (provide Cat6a cable)
7. Intel Pentium 4 class processor

B. The Digital Video Encoding station is MM-1280 by ETR, or equal.

2.20 FACTORY BUILT AND CERTIFIED CENTRAL HEADEND

A. The Central Headend shall be located in the MDF and shall be capable of serving additional school buildings.

B. The Manufacturer shall request a VLAN and network setting specifically for the Central VOD, IPTV, and AV Management System. These network settings shall be placed in a spreadsheet listing Architectural Room Assignment (from Plans), Actual Room #, Projector/TV Type, Manufacturer/Model #, Wire Closet, Patch Panel, Switch Port, etc. It shall also list the IP, Netmask, Gateway, Multicast, for both the TV/Projector and the MM-1271/5 Decoder/Display Controller. This spreadsheet shall be included in the Component Submittal for Approval.

C. Prior to assembly the Manufacturer shall engineer the Central Headend as a CAD drawing. An accurate and detailed Cabinet Drawing and Schematic shall be submitted for approval. These drawings must detail every component, connector, cable, component label, mounting hardware, screws, and network assignment label. Single line drawings with title boxes for components are not acceptable.

D. Provide one 37RU enclosed equipment cabinet with removable side panels and locking rear door. All components shall be rack rail or shelve mounted. Receivers and STB shall be vertically mounted for heat dissipation and captivated to mount. Warmest components shall be located on top, coolest components on bottom.

E. Provide a full time, on-line UPS system providing sine wave correction, voltage regulation, spike suppression, and a minimum of 1,500 watts of backup power. Standby UPS systems are not acceptable. The UPS shall provide full time protection for the MediaServer, Digital Video Server, Bulletin Board PC, CATV Receivers at a minimum. UPS must have 208v 30 amp twist lock plug for connection to rack power outlet.

F. Provide 19” rack mounted HD monitor with XGA cables installed for the MM-3000-D MediaMaster VOD Server and the MM-8100PV Bulletin Board Server, and HDMI installed cables for CATV STBs. Include AV switcher to manually select these inputs.

G. Provide surge protected full length power strips with 10% spare outlets.

H. Every component shall be factory installed by the Manufacturer and pre-programmed with Owner provided IP Addresses, Netmasks, Gateways, Multicast Addresses, and Remote Access Assignments.

I. The Manufacturer shall label every component, test and certify the entire headend, crate assembly, ship on air ride moving truck, deliver directly to MDF room, install final cables and connections, test system with Owner present, train Owner how to push VLC Player and automate MediaMaster Launch Script to all computers, train Owner's Trainers.

2.21 MEDIAMASTER LIVE PUBLIC MEDIA PORTAL

A. The Public Media Portal shall consist of, but not be limited to the following:

1. Provide a Public Media Portal that allows Users to make on-demand and live video that resides in the VOD & IPTV system available via the Owner's public Web site. Selected video titles, live, and Bulletin Board streams within the system shall easily be shared within the Media Portal interface on the school's Web site. Features shall include search, content descriptions and social media integration. Media Portal should be able to be embedded within a client's Web site so it resides within their Web site pages.

2. The Internet Portal Server shall be located in the MDF. It shall be rack mounted into the media cabinet to keep it clean and prevent bumping and jarring. It shall feature forced-air cooling. Cooling air shall be drawn through a front cleanable filter and exhausted out of the rear of the case. The rack mount case shall be constructed to provide adequate airflow over all components.

3. System proposed must include hardware, software and end-user interface features as necessary to automatically transcode uploaded video files into a standardized H.264 format without additional user intervention. Must support transcoding of industry-standard videos that are uploaded including Windows Media, AVI, OGG, MPEG1, MPEG2, MPEG4 (.m4v, mp4, h.264) and QuickTime (mov).

4. Ability to modify the default resolution, bit-rate and bandwidth setting for the transcoding.

5. After transcoding the video files must be moved automatically to the Streaming VOD Server for storage and the database must be updated so the new H.264 format video is accessible for on-demand viewing through the user interface without having to upload again.

6. Must include hot-swap drive bay, minimum of a 146GB hard drive with hot-plug caddy.

7. Encoder must support encoding in a quality-level from 128kb/s up to 7Mb/s and up to 720x480 resolution and 30fps bit rate.

8. Encoder must support encoding and live streaming of 12 unique video feeds. Each of the 12 channels must simultaneously be able to stream at a minimum of 2Mb/s, 720x480 30fps without dropping a frame in either Windows Media or H.264 format.

9. Must support delivery of multicast and up to 40 on-demand unicast streams for every channel as well as support redirection to the central streaming server for an increased number of unicast viewers of those streams over the WAN.

10. Must be controllable through the system's web-interface including start, stop, preview and scheduling of encoding events.

11. Must support recording of the encoding channels directly into the digital library and centralized streaming server storage making them available on-demand after the event is complete.

12. Adaptive bitrate technology polls the client's browser and bandwidth, then automatically optimizes the stream bitrate and resolution to the player's capability.

13. Public Media Portal shall be licensed to Abington High School.

2UILDING CONFIGURATION AND EQUIPMENT

A. As specified above, provide, install, configure:

1. (1) Media Server MM-3000
2. (1) Digital Video Server, 25TB min
3. (400) User Per Site License for MediaServer, Digital Video Server, MediaController, MediaScheduler, MM Administrator, and Playlist.
4. (1) Networked Video Recorder
5. (1) Uninterruptible Power Supply, 208v 30Amp twist lock plug required
6. (1) Menu Channel
7. (2) Addressable Control Modules with 12 emitters
8. (1) Bulletin Board with 6 PrestoVideo HD H.264 Multicast Bulletin Board streams
9. (12) HD H.264 HDMI Multicast Blade Encoders for CATV STBs
10. (1) 17 slot Encoder Blade Chassis & PSs
11. (2) HD H.264 HDMI & RGB encoders in chassis (2 for mobile use)

12. (2) 2 slot encoder blade chassis & Power Supplies
13. (1) CATV on Demand System
14. (12) MyChannel for CATV on demand system
15. (12) 1080p HD CATV Set Top Box Integration.
16. Integrate all 4 Panic Switches and Automatic Lockdown function messaging of VOD System Software.
17. Communications Subcontractor's shall coordinate with 27 40 00 Communications subcontractor to pull RS-232 control cabling for interactive flat panel RS232 control via the T1 and V faceplates in all rooms with those symbols. Terminate RS232 cables
18. Communications Subcontractor's shall install and cable all Owner provided CATV service provider's IRDs (12) for integration into the system.
19. Fourteen (14) 65" TV. Provide tilting wall brackets.
20. One (1) 46" TV. Provide tilting wall brackets.
21. Two (2) 84" TVs. Provide tilting wall brackets.
22. One (1) 90" TVs. Provide tilting wall brackets.
23. Fabricated Head end racks with elevations.
24. Digital Video Encoding Station
25. Provide all software for the IPTV system needed to view content to the Owner in February of the year the school is scheduled to be completed for school PC imaging to commence.
26. Provide and install black Cat6A network patch cable for all STBs and HDMI cabling to local TVs anf T1 faceplates at all locations. Provide and install all cabling at Auditorium eq rack, café eq rack, video wall eq rack, and audio cables to all voice lift systems.
27. Provide and install 127 HD IPTV STB decoders. Provide all applicable programming required for control of projectors, TVs and interactive flat panels.
28. Public Media portal (MediaMaster Live) with 1 building licenses
29. All cabling required for a complete and functional installation.
30. Any other equipment, licenses or devices required or specified not specifically listed above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Notify local cable service provider regarding project requirements and schedule. Ensure that cable service provider completes their portion of Work in timely manner to not interfere with project schedule or other trades. A flat signal of +25dB @ CH2 through +25dB @ CH70 shall be requested.

B. All cables originating from outside building grounded at nearest point of entry.

C. Extend or relocate incoming CATV service to connect to head end rack equipment. Provide appropriate multisswitches, taps and splitters.

D. Seal all penetrations per electrical wiring methods specified for this Project.

E. All vertical cable runs installed in concealed conduit/raceways. Surface mount raceway allowed only where specifically shown on drawings or where approved by architect. Exposed or unprotected cabling is not allowed.

F. Make any bends in cable in 90-degree increments while maintaining less than minimum cable bend radius. All cable routes parallel or perpendicular to building lines and installed to prevent any cable from crossing or wrapping around bundle. Service loops or excessive slack not allowed. Provide for neat tangle-free cable route.

G. Equipment cabinet(s) anchored to wall or floor utilizing an approved method.

H. All head-end equipment securely installed within equipment cabinet(s) by screws, bolts, and nuts or by method approved by manufacturer. All holes intended for equipment mounting used for securing equipment to rack. Provide all exposed hardware in same color and type, preferably matching cabinet finish (i.e., black cabinet-black rack screws).

I. All cabling entering video equipment cabinet(s) installed in conduit or raceway. All cabling within cabinet neatly bundled and secured with tie wraps to cabinet. Avoid cable strain on connectors/terminations. Do not use point of connection to serve as support for cable bundle.

J. All rack ground bars grounded to equipment ground bus, in nearest power panel, utilizing 6 AWG THHN. Ground wire concealed in metallic conduit containing no other power conductors. Ground rack-to-rack ground bar by NEC approved method.

K. After installation of wiring and equipment has been completed, test all cabling to ensure continuity, freedom from grounds (except "made" grounds and those required for protection), and insulation resistance, in accordance with "underwriter's requirements and electrical regulations. Furnish and use suitable instruments such as ammeters, voltmeters and ohmmeters.

L. Prior to final acceptance, provide accurate documentation listing all equipment installed under this Section, including following information: equipment description, equipment part number, equipment serial number, manufacturer’s warranty period, and location of equipment. Any information found to be inaccurate during three-year warranty period requires Communications Subcontractor to physically re-verify all equipment information at no additional cost to Owner. Complete re-verifications within 1 week after notification of any discrepancy. Submit copy of all documentation to Technology Director.

M. For every piece of equipment installed under this Section, deliver, in one delivery, associated manufacturer’s manuals in addition to maintenance manuals specified in other Sections of Project Manual. Provide Owner 3 copies of all material, and architect one copy.

N. Provide installation and start up of all systems under direct supervision of local agency regularly engaged on installation, repair, and maintenance of such systems.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. Test every television outlet for signal level, clear picture and remote origination/control (as applicable).
2. Test all head-end equipment for proper frequency, audio/video carrier levels, and RF level outputs. Adjust all levels per manufacturer's recommendations.
3. Perform tests to all systems under direct supervision of manufacturer's representatives or accredited agencies for all specified equipment and services.
4. Submit all test results in tabular format with reference to or backed up by equipment/riser diagram that accurately represents installed system.
5. Submit written test report from authorized representative of equipment manufacturer stating that system has been tested and is in working order prior to final inspection.
6. Architect and/or Owner's representative reserves right to observe testing.

3.3 DEMONSTRATION

A. Owner's Training: Provide minimum 24 hours of training for Owner's personnel used at Owner's sole discretion and scheduled by Owner to fit Owner's needs.

1. Training scheduled by Owner in blocks of 4-8 hours.
2. Include all per diem and travel costs in cost of training.
3. Include following minimum content in training:

    a. General systems overview describing sub-systems and their relationships with each other.

    b. Specifics on sub-systems and how to maintain them to ensure reliable operations.

    c. Operation of equipment to perform intended tasks, including (but not limited to) remote origination, camera operation, television operation, cable patching, equipment replacement and so forth.

    d. Provide written documentation for all training attendees to supplement training (i.e., diagrams, training outlines/highlights.)

4. All training materials shall be provided to the Owner in digital format, and all training shall be video recorded by the communications subcontractor and provided to the Owner on DVDs.

END OF SECTION

SECTION 28 00 00

ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the installer responsible for all work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY – Any and all cabling mentioned herein and required to complete the work of this section shall be coordinated with the communications subcontractor of this section, and provided and installed by the Structured Cabling communications subcontractor of section 27 10 00 so long as it does not void any manufacturer warranty in this section. The communications subcontractor of this section is responsible for any cabling required by the manufacturer to ensure the manufacturer’s warranty. Electrical subcontractor is responsible during the bidding phase to coordinate cable responsibility with all sections of work in Divisions 27 and 28. The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all cabling work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows: all access control, intrusion detection and video surveillance cabling, parts and equipment specified below, integration between systems, and programming of equipment and devices to complete installation and testing of the systems to be used as complete access control, intrusion detection and video surveillance systems.

A. Access Control System, Proprietary specification of Genetec, including, but not limited to, the following:
   1. Provide and install a server running Genetec Fail Over Directory Role to allow and provide redundancy with the existing server that will be utilized for the access control system in the Middle School. Server shall meet recommended manufacturer specifications.
   2. All SMAs for cameras, card readers and the fail over directory role software. See warranty section below for length of SMA.

3. Enrollement Station
4. Licenses for all cameras and NVRs
5. Licenses for integration with the intrusion system, if required
6. Software floor maps with all cameras and doors for the Middle School building
7. Panels and devices to provide card access, motion integration and door monitoring as shown and specified below.
8. The access control system shall be integrated with intrusion detection devices (motions and door contacts).
9. Access control devices (ie: prox readers)
10. Door, overhead door and roof hatch contacts, DPDT, installation, wiring, and integration to both access control and intrusion detection systems.
11. IR Request to Exit (REX) devices, wiring, installation and integration. REX devices are required at every door with a contact, regardless of whether or not the door has access control devices.
12. Guarded/shielded panic button (PB) devices input devices at locations shown as PB on the drawings to initiate immediate lock down of the access control system as defined by the Owner. Each PB shall be a different input to the system, allowing different configurations dependant on PB locations.
13. Provide inputs to integrate all motion detectors in stairwells, vestibules, hallways and any other locations that may be noted on the drawings. Wire and integrate motion sensors outputs from intrusion system to access control system. Provide all licenses required. Provide outputs from intrusion to access control system for all motions noted above and on the drawings.
14. Any other hardware/software/licenses required to ensure a fully functional access control security system, intrusion detection system, and CCTV system not specifically listed in this specification.
15. The work of this section is shown on Technology Drawings designated by a T.
16. No corridors or speaces are air plenums. No cabling needs to be plenum rated.
17. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
18. All systems and components shall have been thoroughly tested and proven in actual use.
19. Provide in addition to all modules/blades required for a fully functional system, 2 alarm input blades and 2 relay output blades in every IDF and the MDF for future integration needs.
20. Provide all integration, software maps, and programming required to properly populate software maps to allow the owner to see card readers, cameras and doorways. When a user presents a card, the user information shall be presented on the display over the map, as well as the related camera with the portal (both inside and outside cameras). To view a camera on the map, the user simply has to click the camera icon at the location on the map.
21. Coordinate and program zones with the owner, to include after hour use zones
22. Provide partitioning license so the system may be expanded to provide access control for other buildings within the town/district. System is required to integrate with Active Directory. Provide license if required.
23. Drawing symbols for this section: DC, RH, OH, CR, PB, KP, MO, VCS, VES, PS, X.
24. Coordinate door actuator (provided and installed by door hardware subcontractor) opening portals with valid card access requirements. See door hardware specification 08 71 00 for door operating descriptions in regards to access control.

25. Provide and install inline surge suppressors to hardwired electrical feeds in all access control panels not protected by a UPS.

B. Intrusion Detection System

1. Every wired contact and motion shall be individually ID reportable. Communications subcontractor of this section shall provide laminated color coded floor maps no smaller than 21”x15” of the building, which clearly shows all door contacts by door number and contact ID, motions by ID, room numbers, hallway numbers, building ‘zones’, and keypad locations with ID. Mount maps as directed by the Owner.
2. All motions shall be placed to minimize false alarms
3. Coordinate and program zones with the owner, to include after hour use zones.

C. Video Surveillance System

1. IP based video surveillance system. Current system shall be expanded to provide video surveillance for the Middle School. Provide active directory integration licensing (VMS, NVRs, cameras). Provide and install NVRs as specified below.
2. Category 6A cabling for each camera is provided and installed under section 271000.
3. Provide yellow Cat6a patch cords from the CCTV jack to the cameras.
4. The owner shall determine during programming which cameras are to be displayed on the software maps. Provide all cameras licenses for all cameras with the CCTV management system.
5. Communications Subcontractor must work with owner to define a specific sequence of operations for the camera control system, software client, NVR, and manual controls. Operations will include camera tours, sequence for alarm management, if applicable, or loss of signal. Camera controls shall be programmed with macros and programming sequences to provide camera tours, quick call up of cameras, partitioning, and loss of service alerts. All programming and sequencing is included in the bid.
6. Provide snapshots of every camera, and review with the owner and adjust views of each camera as necessary for final view approval of the owner.
7. Program and group cameras as per owner direction.
8. Change default passwords of all cameras and the NVRs. Coordinate with owner.
9. Set camera time to NVR time. Set NVR time to a time source.
10. H.264 shall be used for the record stream, and cameras shall be set to record on motion.
11. Power over Ethernet switches shall be provided by the owner.
12. Camera viewing and stored video shall be accessible from the network.
13. The NVR System shall utilize IP based network video recorders (NVR), which will allow simultaneous recording and remote access of live streams for the video cameras.
14. The NVR shall be a true digital system that can receive digital images/video streams over the network and record them in a digital format.
15. The NVR shall be compatible with the specified IP cameras. NVR solution shall accommodate the proposed number of cameras plus 10 (per NVR).
16. Viewing and monitoring of the NVR will take place remotely over the Owner’s network using existing computers.
17. The NVR system shall be a non-proprietary system. The open-architecture platform shall run on off-the-shelf PC servers and workstations and deliver universal support for IP and encoders for all of the specified manufacturers.
18. Mounting Brackets and lenses: Mounting brackets and lenses have been specified on the drawings to indicate the style of mounting for interior and exterior cameras and the types of lenses to be used. Communications Subcontractor is responsible for ensuring

that the correct mounts and lenses for the distance requirements are used for the camera system specified.

19. Provide and install dedicated VMS server in accordance with VMS manufacturer's recommended specifications in addition to all NVRs specified
20. The specifications provided are to provide a general description of the operating criteria of the system. Communications Subcontractor is responsible for providing a fully operational system.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. SECTION 26 00 00- ELECTRICAL All electrical work related to items in this Section.
2. SECTION 27 10 00- STRUCTURED CABLING
3. SECTION 27 40 00 – AUDIO - VIDEO COMMUNICATIONS
4. SECTION 27 50 00- DISTRIBUTED COMMUNICATIONS AND MONITORING
5. SECTION 27 70 00- VIDEO DISTRIBUTION SYSTEM
6. SECTION 14 24 24 – HOLELESS HYDRAULIC ELEVATORS
   a. Coordinate cameras (provided in this section) and installation with elevator contractor.
7. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

1.4 REFERENCES

A NFPA 70 - National Electrical Code.

1. UL294 - Standard for Access Control Systems.
2. NFPA 72 - National Fire Alarm Code.
3. NFPA 101 - Life Safety Code.

1.5 REGULATORY REQUIREMENTS

A Systems shall be UL-Listed.

1.6 SYSTEM DESCRIPTION

A. The specifications have been based on the Genetec access control system and related components.

B. The Genetec Access Control System shall monitor and control facility access, and shall perform alarm monitoring, camera and video monitoring and communications loss monitoring. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. The system shall be controlled from a web browser and thick client software. The system shall provide control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless

networks, and the Internet. The system shall provide email and/or text message alerts for all alarm conditions and threats.

C. The access control system shall be integrated with the CCTV system. All cameras shall be displayed/shown on the access control software maps and be accessible within the access control system.

1.7 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit under provisions of Section 01300. Tabulate and index all pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:
   1. Submit five (5) copies of:
      a. Product Data Sheets.
      b. Installation Instructions.
   2. Authorized Dealer Certificate and Certified Training Certificates of communications subcontractor who will be installing equipment.

C. Shop Drawings:
   1. Submit five (5) copies and digitally in AutoCAD 2000 or later format on a CD (5 copies), shop drawings, including:
      a. Layout of all equipment and locations supplied AutoCAD drawings, include labeled wiring risers.
      b. Security Console elevation drawings.
      c. Field Controller equipment location wall layouts, including size requirements.
      d. Detailed wiring diagrams of Field Controllers, Door Details, and head-end devices.

D. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 5 copies and digitally in AutoCAD 2000 or later format on a CD (5 copies).

E. Operation Data: Include five (5) copies of the software Administrator and Operator Manuals.

F. Maintenance Data: Include five (5) copies: maintenance and repair procedures.

1.8 QUALITY ASSURANCE

A. Manufacturer: Each system (access control, intrusion detection, video surveillance) shall be from a single-source manufacturers that specializes in each system with a minimum of 5 years experience.

B. Communications subcontractor: Company specializing in intrusion detection, video surveillance and access control systems with a minimum of three years experience on systems of similar size and scope. Technicians working on project must have been certified on the hardware and software used for this project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Owner will provide, on-site, a secure, dry, locked storage area for all equipment delivered

under this scope of work.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the date of final acceptance by the Owner. For support agreements from a manufacturer that are in 2 year increments, provide 4 years warranty and software maintenance/subscription for those systems.

B. Provide any software maintenance updates or upgrades at no additional cost to the Owner for this period.

C. Perform two (2) scheduled preventative maintenance site visits per year during the warranty period.

D. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

E. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

F. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

G. Provide 3 years of central station monitoring of the intrusion system. Program responses and call backs with the owner.

H. Communications subcontractor shall conduct warranty repairs on site unless prohibited by the manufacturer’s warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

I. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

1.12 EXTRA MATERIALS

A. Provide one (1) each of the following components to serve as system spares:
   1. Output Blade
   2. Input Blade
   3. Access Control Blade

4. One Prox reader

PART 2 PRODUCTS

2.0 PROPRIETARY SPECIFICATION

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the Genetec Synergis Pro Access Control System and Omnicast Video Management System and related components.

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Contractor shall not to order any materials until approval(s) are received in writing.
   1. Requesting substitutions shall be at the Contractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

2.1 ACCESS CONTROL (2.1 - 2.23)

A. The drawings and specifications have been based on the Genetec access control system and related components.

2.2 UPS

A. UPS:
   1. The UPS (Uninterruptible Power Supply) for the Server shall provide for 20 minutes of continued operation in the event of an AC Power Failure. Size according to system requirements. UPS shall be 208v 30 amp single phase with L6 twist lock plug input.

2.3 OVERALL SYSTEM CAPABILITY

A. Provide and install a Fail Over Directory Role and server at the Middle School. Configure and program the server to provide redundancy of the existing Genetec system. All access control and programming shall be performed on the existing genetec system. Program the Middle School in accordance with the owner direction concerning partitioning of the system. Communications subcontractor of this section shall perform all programming of the system for access control (to include adding users and modifying existing users in regards to the Middle School project), integration with intrusion motion detectors, and CCTV integration programming.

2.4 HARDWARE REQUIREMENTS

A. The GENETEC Security Management System shall employ a modular hardware concept that enables simple system expansion and utilizes a three-tiered hardware hierarchy.

1. Provide and install enclosure, power supplies, surge protection and all application extension blades for a complete and operable access control system. Each of the application blades shall connect to and manage a set of inputs, outputs and readers.
2. The enclosure and blades shall run on the existing building TCP/IP networks and shall be configurable for access from separate subnets, through gateways and routers, and from the Internet.

B. Provide application blades, enclosures and power supplies in quantities necessary for design intent. The Application blades shall interface with the access control system through the Network. The Application blades shall be blade-style circuit cards. There shall be three types of Application blades:

1. Access Control blade: shall support 2 readers (minimum- input devices such as keypads, RFID devices or Biometric readers), 4 supervised inputs and 4 relay outputs.
2. Supervised Input blade: shall support 8 supervised inputs. Supervised input connectors are 2-pin. The system shall support a wide variety of input supervision types including normally-open circuit and normally-closed circuits, and zero, one or two resistor configurations.
3. Relay Output blade: shall support 8 relay outputs. Relay output connectors are 3-pin. Both normally-open circuit and normally-closed circuit output devices are supported. The relay outputs shall support any output devices that operate on the following maximum electrical ratings: 30 Volts DC or AC, 2.5 Amps inductive or 5.0 Amps non-inductive.

C. Provide the above blades in the quantities required for a fully functional and operational system. Provide inputs for integration of all hallway, vestibule, stairwell motion detectors, and any other motions noted on the drawings.

2.5 SOFTWARE FLOOR PLANS

A. The Genetec system shall provide graphic floor plan capability including graphic display of links to other floor plans, alarms, system resources such as portals, IP video cameras, inputs and outputs.

1. The Network Administrator holding at least a ‘Setup’ user role shall be able to graphically configure device icons onto the floor plan images, and to upload additional floor plan images.
2. It shall be possible to create floor plan groups for the purpose of assigning or withholding assignment of these groups to system user permissions known as Custom User Roles. If a floor plan group is assigned to a particular system user then the floor plans in that group shall be viewable by that system user.

2.6 VIDEO MANAGEMENT INTEGRATION

A. General: The Genetec Access Control System shall support the integration of Digital Video Recorders (DVR) supporting analog video cameras and Network Video Recorders (NVR). This integration shall allow the viewing of live streaming video in the browser interface and recorded video playback.

1. Events in the alarm subsystem can initiate video recording. Video motion detection, camera up and camera down messages from the VMS can initiate alarms.

2. It shall be possible to monitor DVR and NVR cameras in the same views as IP cameras. VMS events shall be logged in the system activity log. It shall be possible to view recorded video of events from the Activity Log.

B. Integrated DVR/NVR Systems

1. All NVRs shall be fully supported by and fully integrated with the Genetec system.

2.7 CARD READERS

A. Proximity Readers:

1. Black or Gray Short Range Proximity Card Reader which includes mounting base, backbox and bezel. Wiegand interface and clock-data interface compatible, 125kHz, integral tamper switch, indoor/outdoor and fully compatible with the GENETEC Security Management System. Designated as CR on technology drawings. Use thin profile card readers on the frame of glass doorways.

2.8 BACK BOXES. Backboxes for all security devices in quantities necessary for design intent. Provide backboxes and deliver to electrical subcontractor for installation.

2.9 POWER SUPPLIES. Power supplies in quantities necessary for design intent, Altronix model AL600ULACM or equal. Provide inline surge suppression on all power supplies and power supplies in access control enclosures.

2.10 DOOR CONTACTS. Provide and install/wire/integrate DPDT door contacts for all door leafs as shown on the drawings (designated as DC). GE model 1076D-G or equal.

2.11 OVERHEAD DOOR CONTACTS. Provide and install/wire overhead door contacts, for all overhead doors as shown on drawings (designated as OH), Sentrol Model 2507AD or equal

2.12 ROOF HATCH CONTACTS. Provide and install/wire Roof hatch door contacts as shown on the drawings for all roof hatches (designated as RH).Sentrol Model 2507A or equal.

2.13 REQUEST TO EXIT DEVICES. Install and wire and integrate request to exit devices on all doors with door contacts (designated as DC) unless otherwise noted, Bosch model DS/TS 151i or equal. Ensure access control system can ignore REX door contact shunting and alert on portal opening from either side even if a rex is installed, as determined by the owner. Also provide rex as shown/noted if in door hardware specification and door hardware schedule.

2.14 PROX CARDS. Photo-badge combination Mag Stripe/Prox Cards, 125kHz, lifetime warranty with labels. Provide 200.

2.15 PANIC BUTTONS. Provide and install ‘panic button’ devices (contact closure button) in locations marked as PB on the drawings to allow the owner to immediately initiate a lock down of the access control system as per owner’s direction. Provide press button devices with a guard or shield to avoid accidental triggering of the system. Each PB shall have its own input to the system.

2.16 INPUT/OUTPUTS

1. Provide for 10 inputs from intrusion detection panel to allow access control to integrate with the intrusion detection system. These do not count as ‘spare’.

2. Provide 10 outputs from access control to the intrusion detection system. These do not count as 'spare'.
3. Provide inputs for access control to allow integration of all hallway, vestibule and stairwell motion sensors and any other motion sensor noted on the drawing (or provide all licensing if DMP panel installed by communication subcontractor with GENETEC).
4. Provide output relay from access control system to intrusion detection system to allow intrusion detection system to dial 911 if desired, and notify specified personnel when a Panic Button is pressed or a lockdown is initiated in access control.
5. Provide relay output (4 total, two outputs to each system) from access control to the IPTV head end and the Public Address system for when a lockdown is initiated in access control. Leave 25' coiled at each system head end.
6. Provide output to fire alarm control panel, leave wire coiled 30' above panel. Coordinate access control lockdown integration with fire alarm subcontractor and owner.
7. Provide in addition to all required blades for rex's, door contacts, motions, card readers and above requirements 2 additional relay output blades and 2 additional alarm input baldes in EACH IDF and the MDF for future integration needs. Provide and install additional network cards and panels/enclosures required to accommodate any spare blades required in each location.
8. Provide 23 input relays for outputs from the following systems to alert the owner of the following system alerts. The following alarms will be run to the plywood back board, labeled and coiled 30' by the individual subcontractors. Communications subcontractor of this section shall install each alarm into the GENETEC system and program notifications as directed by the owner:
   a. Boiler failure
   b. Kitchen freezer high temp
   c. Kitchen cooler high temp
   d. Acid neutralization system failure (2 alarms)
   e. Recycled water system, control fail safe
   f. ACC-1
   g. ACC-2
   h. Lift station failure (6 alarms: high water, low water, pump fail (x2), intrusion, lag pump)
   i. Hot water pump fail
   j. Chilled water pump fail
   k. Generator fail
   l. Elevator (3 alarms)

2.17 ENROLLMENT STATION

A. Provide the following:
   1. A complete photo ID Badging system, including: 10MP camera with Synchronized Flash (EOS Rebel XS or equal), Tripod, and backdrop
   2. Provide a high definition color dual sided card printer and 4 Printer Rolls. Printer part number Fargo HDP5000 by HID or equal. Provide printer with dual side printing, dual side laminating, and mag/prox encoding options.
   3. Provide combination magnetic stripe / prox reader for card enrollments, integrate and install to access control system in portable enclosure on the badging desk. Coordinate final installation location with owner.
   4. Provide PC, keyboard, mouse and 19" monitor (min) with windows 7. Provide patch cord to connect to network.

2.18 VIDEO ENTRY SYSTEM

A. General
   1. Furnish and install a complete video/audio entry intercom system with independent door release mechanisms according to the following specifications. Manufacturer's names and catalog numbers used herein establish the required type, quality and operating characteristics. Provided system shall have at a minimum the following functional capabilities.

B. The two (2) indoor room stations (two in 101B - locate at VCS symbol locations) shall be complete with handsets, 7" touchscreen color desktop mounted video monitor receivers, door release buttons and desk stands. Provide and install:
   1. One (1) Aiphone 7" touchscreen color master control station with desk stand, part number JP-4MED with power supply (part number: PS-2420UL)
   2. One (1) Aiphone 7" touchscreen color sub-monitors JP-4HD with desk stand.
   3. One RY-3DL selective door release adaptor.
   4. The remote video door stations shall be complete with pan/tilt/zoom color camera, or audio function only as specified below. They shall have vandal resistant hardware. Provide and install:
      a. One (1) Aiphone video entry door station outside main entryway C100D as shown by VES symbol. Station shall have tamper proof stainless steel housings. Aiphone part number JP-DVF. Coordinate back box location and installation with electrical subcontractor. Door release shall unlock door. Use A3 & A1 (See technology drawing) to bring wiring to the control stations as indicated above. Provide all programming of buttons for desired functions.

C. The following hardware will be utilized to support the video entry system.

   1. Manufactures wiring extends the warranty and shall be used when ever possible. Aiphone #87180250C, 2 cond 18AWG solid PE insulated, non shielded and CAT5e cable (CAT5e is non Aiphone brand).

   2. Utilize 2 blank ports on each A3 & A1 faceplate for wiring each VCS to its respective cabling.

2.19-2.23 BLANK

2.24 INTRUSION DETECTION SYSTEM (2.24 – 2.47)

2.25 Security Control Panel

A. The base panel shall have a capacity of 16 independent door/keypad addresses, each with four zones. The system shall offer a seamless integrated compatibility with hard-wired and / or wireless zone expansion equipment for at least 200 wireless zones and / or a maximum of 574 hardwired zones.

B. All zones shall be fully supervised and programmable. Panel shall be complete with integral power supply and supervised battery charger, auxiliary power for powering security detection devices, programmable switched auxiliary power supply for 4-wire smoke detectors, integral supervised digital alarm communicator, supervised bell/siren output, and two general purpose programmable outputs which can be programmed as general purpose outputs or as the system's addressable loops. Recommended panel to integrate with access control (GENETEC system): DMP Model XR500N Series or equal

C. Provide and install inline surge suppressors to hardwired electrical feeds, or at power outlet if plugged in, at all intrusion detection system panels not protected by a UPS.

2.26 System Communication Bus

A. The system shall be complete with a standard, non-shielded, 4-conductor station wire bus for powering and communicating with remote hardwired system expansion modules and devices. For the connection of various system modules, communication bus wire runs (#18AWG) of up to 3500 ft (1066 m.) shall be standard, and the system shall allow for an additional 3500 ft (1066 m.) of communication bus wire for each communication bus expander added.

2.27 User Codes

A. The system shall provide for 1,500 user codes, select-able as either 4 or 6 digits. User codes shall be assignable to one or multiple partitions.

2.28 Partitions

A. The system shall be programmable for up to 16 fully in-dependent partitions, with each partition having its own account code. Keypads shall be assignable as partition keypads or global keypads. Each zone in the system shall be assignable to one or more partitions.

2.29 Scheduling

A. The system shall provide for 99 date schedules with 4 intervals per schedule, 4 holiday schedules with 2 years of scheduling capacity, 50 open/close suppression schedules and 16 automation schedules. All schedules shall be programmable from the LCD system keypads and by either local or remote upload/download.

2.30 Ground Fault Detection

A. The system shall include an integral ground fault detector which shall detect a single ground fault on any extended conductor in the system.

2.31 Supervision

A. Each zone in the system shall be supervised. The base panel and any remote panel with its own AC input shall be supervised for AC loss. Batteries for the base panel and all remote panels shall be supervised for low power and be short circuit-protected. Each addressable device shall be supervised for its presence.

B. The communications bus shall be supervised for low voltage and the presence of each enrolled module and keypad.

C. Digital alarm communicators shall be supervised for telephone line trouble and failure to communicate.

2.32 False Alarm Prevention

A. The system shall include the following false alarm prevention features:

1. audible exit delay, audible exit fault
2. arm/disarm bell squawk
3. urgency on entry delay
4. TLM trouble and low battery trouble transmission delay
5. swinger shutdown programmable by zone

6. transmission delay by zone
7. police code (cross zone) transmission
8. opening after alarm transmission
9. recent close code transmission
10. AC fail

2.33 Power Supply/Relay Output Modules

A. The system shall be capable of including up to 64 fully programmable output relays with form 'C' contacts rated 2 Amps at 30VDC.

B. Relays shall be added in modules of four and may be located anywhere on the communication bus.

C. Each module shall include a supervised 700mA 12VDC battery charger, and integral power supply to supply up to 2.2 Amps of auxiliary power at 12VDC to power directly connected devices or re-power the communication bus.

2.34 Low Power Outputs

A. The system shall be capable of including up to 144 low power outputs with each output able to supply 50mA at 12 VDC. Outputs shall be added in increments of 16 and may be added anywhere on the communication bus.

2.35 System Event Buffer

A. The system shall have a 3,000-event buffer. All events shall be printable from the system printer. The 2,800 most recent events shall be viewable on the LCD sys-tem keypad. All events shall be viewable by up-load/download to a PC.

2.36 System Programming

A. The system shall be fully programmable from the LCD keypads and shall also allow event buffer viewing at the keypads.

B. Separate PC-based upload/download software shall allow programming and operation from a directly connected local computer, or from a remote computer via a telephone line or TCP/IP LAN/WAN communications. Provide and install client software)if required) where directed by the Owner (up to 3 locations) to allow system programming via the LAN

C. Remote access shall be controlled by the owner to prevent unauthorized access.

D. All system programming shall be maintained in non-volatile memory so that programming information is retained even if all AC and battery power is removed.

2.37 System Keypads (Symbol KP on drawings)

A. The system shall accommodate up to 16 LCD keypads which are powered from the base panel four-wire communications bus.

B. LCD keypads shall have a display capacity of at least 32 alphanumeric characters with adjustable brightness and contrast.

C. Keys shall be backlit for low light ease of use. Keypads shall include individual "Armed", "Ready" and "Trouble" indicators, three keypad-activated alarm keys, and five programmable function keys. DMP Model:7060A or equal.

2.38 Central Station Reporting

A. The system shall provide high speed 10 bps and 20 bps 1400/2300 Hz handshake, Contact ID and SIA reporting formats and shall be capable of being programmed to call up to 3 telephone numbers.

B. The system shall also allow communication to a pager. The telephone numbers shall be programmable for backup dialing should the primary number fail.

C. The system shall be programmable for split reporting so that alarms/restorals, openings/closing and miscellaneous events can be sent to different telephone numbers.

D. The system shall report a separate account code for each partition and for non-partition (system) events.

E. The system shall provide opening/closing scheduled suppression to prevent opens and closes from being reported to the central station.

F. The system shall be capable of reporting all alarms, troubles, and system status information by combinations of all communication methods installed including: digital communicator, DVACS, and Cellemetry.

2.39 TCP/IP LAN/WAN Communications

A. The system shall communicate all alarm signals to a central station or dedicated PC a constant connection providing full supervision of the link between the panel and the TCP/IP receiver.

B. Communication shall be via a LAN or WAN, compatible with 10BaseT and 100BaseT Ethernet TCP/IP communications.

2.40 System Printer

A. The system shall have a serial printer installed in the MDF room that prints all system events, alarms and restorals, including the partition, date, and time of these events.

2.41 2-Way Serial Port

A. The system shall support a 2-way data port, offering RS-232 serial communications at data transfer rates of from 300 to 4800 bps. This port shall provide real-time access to all system events and allow system integrators to send control commands to the control panel.

2.42 System Software

A. The base panel shall come complete with the software necessary to implement every system feature and to allow for the addition of every expansion or functional module without changes or addition to the basic software.

2.43 Motion Detectors (Symbol MO in a hex on the drawings)

A. Ceiling mounted 360 degree detection area for a 24ft coverage area. DMP Model AP669 or equal with zone expanders in quantities necessary for design intent. Provide motion detectors with two outputs (one for access control system) in hallways, stairwells and vestibules, and at any other location noted on the drawings or security panel outputs for these motions to the access control system. Provide outputs in quantities necessary for design intent to access control system inputs.

2.44 Addressable Modules

A. Addressable device to monitor alarm, tamper and trouble conditions.

B. Addressable module: shall be DMP 711 Series or equal.

2.45 Input/Output.

A. Provide for 10 outputs to the access control system to allow intrusion panel to integrate with access control (these are not counted as 'spare').
B. Provide for 10 inputs from access control panel to integrate access control with intrusion panel. (these are not counted as 'spare').
C. Provide outputs of all hallway, stairwell and vestibule motions outputs to access control system
D. Provide for input from access control for each panic button shown on the drawings (PB symbol). Program response as per owner direction.
E. Provide for input from access control system of a lock down state initiated in access control system. Program response of intrusion panel as per owner direction.
F. Provide 10 spare inputs and outputs.

2.46 Door Contacts

A. All DPDT door contacts shall have the second set of contacts on all doors with door contacts wired to intrusion detection system.

2.47 Emergency Key Cabinet (Knox Box) Tamper Switch Monitoring (All locations)

A. Provide intrusion detection system input to detect a tamper condition from the tamper switch provided with the Emergency Key Cabinet.
B. Wire and integrate Emergency Key Cabinet tamper switch with the Intrusion Detection System.

2.48 VIDEO SURVEILLANCE SYSTEM (2.48 – 2.54)

2.49 GENERAL

A. Acceptable manufacturers:
1. Video cameras:
a. Panasonic
b. Or equal
2. UPS
a. Tripp Lite
b. Minuteman ED Series
c. Or equal
3. Video Management Software
a. Omnicast - Proprietary

2.50 SOFTWARE

A. The Communications Subcontractor shall supply the licenses per camera integrated into the CCTV system as necessary, and any licensing required for server/software/remote clients (min 20 remote clients).
B. Provide a Video Management Server, and install and configure Video Management Software:
1. Software must be Omnicast, as already existing in the district. These servers shall be added ot the existing district VMS.
2. Optimized recording storage management
3. Must seamlessly integrate with access control system

4. Provide all licenses for video recorders. Provide licenses for all IP cameras.
Video Management Software shall be Omnicast or equal. Provide appropriate Video Management Server meeting manufacturer recommended specifications for the VMS site manager software. Rack mount in MDF CCTV rack. VMS system shall fully support all functions of cameras for complete integration (ie: H.264 recording, record on motion, higher resolution on motion or alarm)

2.51 NVR Provide 8

A. General: IP network based Network Video Recorder System ("System") shall operate on industry standard Microsoft Windows 2003 server, XP Professional or Linux operating system with all the controls done via keyboard and mouse. System shall not include any proprietary hardware such as video capture or frame grabber cards that may cause System instability. System shall be based on industry standard hardware. Provide and install Omnicast software and licenses.
   1. All System configurations, changes, setups and operation shall be available to the System administrator for access and use. System configurations, changes, setups and operation shall be password protected.
   2. NVR: Min Intel Core 2 Duo Processor 2. 66GHZ 1066 MHz FSB, min 8 GB DDR2 SDRAM Memory, (2) 1 Gigabit Network Adapter, min 20 TB useable internal hard drive capacity for data storage in a RAID 5 configuration, min 1TB boot/operating system drive storage capacity in a RAID 1 configuration. Redundant power supplies, DVD-RW drive, 512MB Video Graphics Card, manufacturer supplied 3 year 4 hr response on site 7x24 support. Provide eight (8), rack mountable.
   3. Provide mouse (1), keyboard (1), 17" LCD color monitor (1). Provide a Keybord/Video/Mouse solution for these 9 servers (includes VMS server) to utilize one mouse, one keyboard and one display, rack mountable.

2.52 UNINTERRUPTED POWER SUPPLY (Provide 2 sized to support 9 servers for 3 mins run time)

A. General: Each server/PC shall be supported by an uninterrupted power supply (UPS). The UPS shall provide standby power during blackouts, brownouts, surges, spikes and line noise protection.
   1. Shall have built-in DB9 network interfaces to allow remote management and automatic shutdown.
   2. SNMP manageable
   3. Recharge time: 2-3 hours
   4. Back up time: half load 6 min., full load 3 min. Size according to servers supplied.
   5. UPS devices must be 208V 30amp single phase with L6 twist lock plug. Provide 2 sized to support the 9 servers.

2.53 FIXED NETWORK COLOR CAMERA (Provide 186 WV-NW502S (Symbols C013, C0153 & C133) see T2.2).

The semi-flush-mounted vandal resistant digital signal processing (DSP) 3 Megapixel cameras shall be Panasonic Model WV-NW502S or equal for interior and exterior use. The exterior cameras shall have a sensitivity of 0.3 lux color, .05 lux black and white. The interior cameras shall have a sensitivity of .3 lux color and .2 lux black and white.

A. The camera shall use a Dual Streaming Codec with JPEG and H.264 Video Compression. Camera shall be capable of streaming up to 30ips.

B. The camera's imager and lens assembly shall rotate on a three-axis hinge for optimal camera positioning. The camera shall be able to be semi-flush mounted on a wall or ceiling using a standard double-gang 4-11/16" electrical box. The camera shall feature a rugged weatherproof exterior housing with an advanced dehumidification device, base and body as independent

structures, and that meets IP66rating. The vandal resistant camera shall feature a local monitor output jack for picture and positioning adjustments.

C. The cameras shall feature wide dynamic range and smoked domes.

D. The camera shall feature a body-based vandal automatic back focus mechanism for automatic and remote back focus adjustment. The automatic back focus adjustment (ABF) shall engage and reposition the imaging assembly for optimal focus position on automatic or manual switchover from Day to Night Mode and on manual activation at the camera or remote from the camera using a System Controller.

E. The camera shall feature a B/W mode that may be automatically engaged in lowlight level, but also permits the use of an external infrared illuminator, when manually selected. The camera shall incorporate independent automatic Color to B/W switching modes for switchover on light threshold and sensitivity to IR illumination in the 850 nm wavelength (Auto1 and Auto2). Each switching mode shall incorporate two switching threshold light levels, high and low. Each Color to B/W switching mode shall incorporate three duration settings for automated switchover. The camera's video image may be manually changed to upside-down mode to facilitate certain mounting and other applications.

F. The camera shall incorporate a 1/3", 3MP imaging device, have progressive scan, automatic iris, 2.8X min variable focal lens with a focal length of 3mm - 8.5mm minimum. The lens shall be suitable for use in areas where there is a varying light source.

G. Provide PoE heater for exterior cameras.

H. The power source shall be Power over Ethernet (PoE). NO independent AC or DC shall be provided at camera locations.

2.54 FIXED NETWORK COLOR CAMERA, ELEVATOR CAR (Provide 3; (Symbol C122) See T2.2 for details)

The surface corner mounted vandal resistant mini dome color CCD cameras in the elevators shall be a Panasonic Model WV-SW155 or equal. Provide all media conversion equipment, power supplies and coordinate all cabling with 27 10 00 communications subcontractor to connect and integrate elevator cameras to the network and VMS/NVR system. Coordinate with elevator contractor.

Cameras must be fully supported by VMS system for higher recording rates on motion, record on motion, H.264 recoding and for physical alarm input functionality.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions.

B. Coordinate with electrical contractor for door hardware/wiring

C. Install wiring for detection and signal circuit conductors in conduit. Use 22 AWG minimum size conductors.

D. Make conduit and wiring connections to existing door hardware devices. This includes the wiring and installation and integration of door key switches, rex devices whether in door hardware or IR above door devices, door contacts (must be DPDT, with 2nd set for intrusion detection system) where provided.

E. Door prep for door contacts will be provided by others. Power for access control power supplies will be provided by the Electrical subcontractor. Access control power supplies shall be connected and wired by the communication subcontractor of this section. Communication subcontractor of this section is responsible for installation and wiring of all key switches and to provide appropriate input to the access control system for desired functionality.Where FACP is indicated on the drawings, the door shall be unsecured during activation of fire alarm system. Coordinate this requirement with the 26 00 00 communication subcontractor.

F. The communication subcontractor of this section is responsible for providing, wiring, installing, connecting and terminating all access control and intrusion devices to include door contacts, (2nd set of contacts for Intrusion Detection Section) request to exit devices, card readers, power supplies, inputs from intrusion detection (motions), and outputs to intrusion detection. A request to exit signal shall only shunt the door contact, it shall not unlock a secured door.

1. The communication subcontractor of this section is responsible for coordinating with the 27 10 00 communication subcontractor for all Cat6A LAN drops required to support access control devices, intrusion devices/panels, and video surveillance components if not provided for on the drawings, or to provide and install the required cabling. Include in bid all work required if not shown on the drawings. Include all patch cables in IDFs and MDF to connect access control devices. The intent of this specification is for a complete and functional access control system.

2. Electrical subcontractor is responsible for providing hard power connections to all access control and intrusion panels from the corresponding emergency power panel servicing the MDF or IDF. Panels shall not be “plugged into” the wall.

G. Intrusion system shall be provided with a battery to provide 8 hours of function with no utility power.

H. Install motions to provide largest coverage area possible. Do not install next to hot/cold air vents. Set motions to minimum sensitivity.

I. Adjust all devices to achieve proper operations.

J. All camera domes shall be smoked

3.3 FIELD QUALITY CONTROL

A. Test in accordance with NFPA 72 - National Fire Alarm Code

B. Test in accordance with GENETEC testing procedures for " Security Management

System".

3.4 TRAINING All training to be video recorded by the communications subcontractor and given to the owner

A. Provide 8 hours training on video entry system, adjustments, configuration, programming and function. Install client software as directed by owner.

B. Provide Intrusion System demonstration and training, min 8 hours.

C. Provide Video Surveillance training. Min 16 hours of on-site live instruction.

1. 14 hours for Owner's building and grounds staff, principal's and SROs

2. Two separate 1 hour sessions with owner's secretarial staff

D. Provide initial access control system setup training in accordance with owner's directives to include integration of CCTV and intrusion detection (minimum 24 hours). In addition, provide four (4), four (4) hour sessions to train designated System Administrators. The following outline shall be used to provide training:

System Architecture

Controller

Node and expansion blades

Node types

Network port usage

System security

Blades

Access blade, netdoor blade, alarm input blade, temp blade, output blade

Portals

Card holders and access levels

Using readers with keypads

Personal information fields and photo ID

Person photo id

Banner and support setup

Inputs and outputs

Input supervision types

Outputs

- Momentary and scheduled actions
- Holidays and time specs
  - Creating time specs
  - Holidays
  - First in unlock
- Widget desktop
- Threat level management
  - Setting a threat level
  - System lockdown
  - Panic button use and programming
- Changing access requirements
  - Portals, readers, keypads
  - Anti-passback and tailgating
  - Installation support and downloads
- Misc controller defaults and node settings
  - Identifying and connecting nodes
  - Remote node setup
  - Database system backups
  - Backup to NAS or FTP
  - System maintenance and utilities
  - Update system software
  - System shutdown and reboot
  - System restore
  - System reset
- Cameras, events and actions
  - Configuring ip cameras
  - Events and actions
- Floor plans

Integrating NVR recordings

5 steps to setup

Alarm panels

Elevators

Personal information

Reports

Config reports

History reports

Programming system for off hours use, different zones/scenarios

3.5 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services for final system checkout and acceptance testing.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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Section 31 00 00
EARTHWORK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Examine all drawings and all other Sections of the Specifications for the requirements therein affecting the work of this trade. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Architect's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

B. The Contractor shall become thoroughly familiar with the site, consult records and drawings of adjacent structures and of existing utilities and their connections, and note all conditions which may influence the work of this Section.

C. By submitting a bid, the Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

D. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure a steady progress of work under this Contract.

1.2 SCOPE OF WORK

A. Work covered by this specification includes the following but is not limited to:

1. Excavation to obtain subgrade
2. Over-excavation to remove unsuitable bearing materials
3. Proofrolling of exposed subgrade for fill, footings, foundations, slabs, walks, pavements, lawns and grasses, and exterior plants
4. Excavation for footings, foundations, structures and utilities
5. Backfilling of excavations for foundations, footings, walls, utilities, pavements, sidewalks, and landscaped areas with specified on-site and imported materials
6. Placement of bedding, sub-base and base course layers
7. Stabilization/mitigation of saturated or otherwise disturbed materials
8. Final grading
9. Excavation support, shoring or bracing as necessary
10. Required materials testing frequency

1.3 CONTRACT REFERENCE

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

B. Related Sections

1. Section 01 40 00, Quality Control
2. Section 01 42 00, References
3. Section 01 50 00, Temporary Facilities
4. Section 311000 Site Preparation and Clearing
5. Section 323200 Segmental Retaining Wall
6. Section 334000 Storm Drainage Systems

1.4 DESCRIPTION

A. The Contractor shall furnish all labor, material, tools and equipment necessary to excavate materials; segregate, track, handle, sample, analyze, and test excavated materials, backfill, and re-grade as indicated on the Drawings.

B. The Contractor shall use suitable on-site soils and fill, and soil from off-site sources, as needed. ***Please note that not all on-site materials will be suitable for reuse, nor will all required material gradations be present on the site. Imported materials or blending of onsite materials with imported materials are anticipated for this project.***

C. The Contractor shall make excavations in such a manner and to such widths that will give suitable room for performing the Work and shall furnish and place all sheeting, bracing, and supports, if necessary. ***Excavation support is anticipated for this project.***

D. The Contractor shall provide labor and material for all pumping and draining, if necessary; and shall render the bottom of excavation firm and dry and in all respects acceptable. The Contractor shall collect and properly dispose of all discharge water from dewatering systems in accordance with local and State requirements and permits.

E. The Contractor shall raise the Site to final grades and compact the subgrade and intermediate layers to the required criteria set forth within the Section.

F. Routine monitoring of in-place excavation support system shall be provided.

G. Contractor shall protect and moisture condition all on site and imported materials for proper installation, compaction and use. This includes covering, drying, and adding moisture in order to maintain suitable workability of the soil materials. ***Please note onsite and imported materials will not necessarily be encountered, or delivered in a suitable condition as environmental factors prevalent at the time of construction will impact soil materials.***

1.5 INFORMATION

A. Information on the Drawings, Reference Drawings, Geotechnical Reports, and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for information and is not guaranteed.

B. Site Information – Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that Owner will not be responsible for interpretations or

conclusions drawn there by the Contractor. Data is made available for the convenience of the Contractor. The Owner, Architect and Engineer assume no responsibility for the accuracy of the data other than at the particular locations and at the time the explorations were made.

C. The Contractor, at his/her own expense, may conduct additional subsurface testing for his/her own information after approval by the Owner.

1.6 SUBSURFACE CONDITIONS AND SPECIAL SITE CONSIDERATIONS

A. Soil borings and test pits have been made by qualified Contractors prior to this Contract. This information shall be made available to bidders as specified under other Sections. Procedures for dewatering, areas to receive special fill and other methods and procedures specified herein shall be supplemented by this information. For purposes of this specification, this information will be referred to as the Geotechnical Report. Where procedures within the report vary from procedures as specified herein, the specifications shall govern. The Geotechnical Report is provided elsewhere in this manual,

B. The Geotechnical Report notes that based on the grain size analysis, the existing fill does not meet the gradation requirements for Structural Fill or Ordinary Fill. All materials to be used as fill should first be tested for compliance with the applicable gradation specifications. The contractor is made aware of this condition and will not be eligible to receive additional compensation for imported material exceeding the Contractor's initial bid.

C. It is the responsibility of the Contractor under this Contract to do the necessary excavation, filling, grading and rough grading to bring the existing grades to subgrade and parallel to finished grades as specified herein and as shown on the Drawings for this Work. The Contractor shall visit the site prior to submitting a bid to become familiar with the extent of the work to be done under this Contract. The Contractor shall be responsible for determining the quantities of earth materials necessary to complete the work under this Section. All earth materials shall be included in the Contractor's base bid.

D. Test boring locations as depicted on the Drawings are located by tape measurements from existing site features and structures and should only be considered as accurate as the procedure utilized.

1.7 QUALITY CONTROL

A. The Owner will retain a Soils Representative to perform on-site observations and testing during the construction operations. The service of the Soils Representative may include, but not be limited to the following:

1. Observation during excavation and dewatering of building areas, parking areas and controlled fill areas.
2. Observation during placement and compaction of fills within the building area, parking area, waste water treatment plant area, and controlled fill areas.
3. Observation, construction and performance of water content, gradation, and compaction tests at a frequency and at locations to assure conformance of this Specification. The results of these tests will be submitted to the Architect and copied to the Contractor, on a timely basis so that the Contractor can take such action as is required to remedy indicated deficiencies. During the course

of construction, the Soils Representative will advise the Architect, in writing, with a copy to Contractor if, at any time, in his opinion, the work is not insubstantial conformity with the Contract Documents.

Material	Responsible Party	Situation	Test	Minimum Frequency
Structural Fill/ Ordinary Fill/ Gravel Borrow/ Common Borrow/ Bedding Material/ Crushed Stone / Pea Gravel	Contractor	Source Investigation	Grain Size through 0.002 mm Moisture Density Relationship	1 per source 1 per source
	Owner	During Placement	Grain Size through 0.002 mm Moisture Density Relationship	1 per 100 tons 1 per 100 tons
	Owner	As-Placed	Dry Density and As-Placed Moisture	2 per lift per location or activity and no less than 1 every 500 sf
Loam Borrow	Contractor	During Placement	PH, Nitrogen, Phosphorous, Potassium, and USDA Classification	2 per Acre
Riprap	Contractor	Source Investigation	Source Material Certification Specific Gravity	1 per source 1 per source
	Contractor	During Placement	Source Material Certification Specific Gravity	1 per 500 tons 1 per 500 tons

B. The Soils Representative's presence does not include supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Soils Representative, nor any observations and testing performed by him, nor any notice or failure to give notice shall excuse the Contractor from defects discovered in his work.

C. The Owner reserves the right to modify or waive Soils Representative services.

1.8 PERMITS, CODES AND SAFETY REQUIREMENTS

A. This project is subject to the Safety and Health regulations of the U.S. Department of Labor set forth in 29 CFR, Part 1926. Contractors shall be familiar with the requirements of these regulations.

B. The Contractor is responsible for the adequacy of the excavation support system and shall retain the services of a Professional Engineer registered in Massachusetts to design any required excavation support systems. The Contractor's Professional Engineer shall practice in a discipline applicable to excavation work, shall have experience in the design of excavation support systems and shall design in conformance with OSHA requirements. The Contractor's Professional Engineer shall provide sufficient on-site inspection and supervision to assure that the excavation support system is installed and functions in accordance with his design. Criteria listed herein defining the responsibilities of the Contractor's Professional Engineer are minimum requirements.

C. All work shall conform to the Drawings and Specifications and shall comply with applicable codes and regulations.

D. Comply with the rules, regulations, laws and ordinances of the City of Beverly, of the State of Massachusetts, appropriate agencies of the State of Massachusetts and all other authorities having jurisdiction. Coordinate all work done within City and State rights of way with the appropriate agencies. Provide all required traffic

control and safety measures, including uniformed police officers per City and State requirements. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor whichever is more stringent.

F. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. The Contractor shall not close or obstruct any street, sidewalk, or passageway unless authorized in writing by the Architect. The Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected hereby. The Contractor shall comply with the time limits established by the terms for trucking onto and off of the site.

H. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Architect in writing, for resolution before the work is started.

I. The Contractor shall comply with all excavation, trenching, and related sheeting and bracing requirements of Occupational Safety and Health Administration (OSHA) excavation safety standards, 29 CFR Part 1926.650 through 1926.652.

1.9 LAYOUTS AND GRADES

A. All line and grade work not presently established at the site shall be laid out by a survey team under the supervision of a Land Surveyor or Professional Engineer registered in the Commonwealth of Massachusetts and employed by the Contractor in accordance with Drawings and Specifications. Basic layout for the project is shown on the drawings. The Contractor shall supply all additional layout and grade control as necessary to properly implement and construct the work. The Contractor shall establish permanent bench marks and replace as directed any which are destroyed or disturbed.

B. The words “finished grades” as used herein shall mean final grade elevations indicated on the Drawings. Spot elevations shall govern over proposed contours. Where not otherwise indicated, project site areas outside of the building shall be given uniform slopes between points for which finished grades are indicated or between such points and existing established grades.

C. The word “subgrade” as used herein, means the surface or elevation remaining after completing excavation or top surface of a fill or backfill required surface of subsoil, borrow fill or compacted fill. This surface is immediately beneath the site improvements, fill materials as dimensioned on the Drawings, or other proposed surface material.

D. All layouts and grades shall be in accordance with Section 01 36 00 FIELD ENGINEERING.

1.10 DISPOSITION OF EXISTING UTILITIES

A. Active utilities existing on the site and work areas shall be carefully protected from damage and relocated or removed as necessitated by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and both Architect and Utility Owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed and suitably backfilled if within the building area. Abandoned utilities outside the building area shall be removed, grouted, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Architect.

C. The Contractor shall notify “Dig Safe” and local utility companies prior to the start of construction. The “Dig Safe” number shall be submitted by the Contractor in writing to the Architect prior to construction.

1.11 SHORING AND SHEETING

A. Provide shoring sheeting and/or bracing at excavations, in order to meet the requirements of OSHA and to assure complete safety against collapse of earth at sides of excavations.

B. If, at any place, sufficient or proper supports have not been provided, additional supports shall be placed at the expense of the Contractor. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

C. All sheeting and bracing not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities or property whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose or otherwise compacted as directed to achieve the required density.

D. Shoring or sheeting shall not constitute a condition for which an increase may be made in the contract price with the exception that if the Architect directs with writing that certain shoring or sheeting shall be left in place, the contract price will be adjusted in accordance with General Conditions.

E. Excavation support systems shall be designed to support the earth pressures, surcharge loads from stored material and construction equipment.

F. Shoring and bracing of trenches and other excavations shall, at a minimum, be in accordance with the latest requirements of the Department of Labor and Industries Bulletin No. 12, Section 10, and all subsequent amendments, and OSHA excavation safety standards.

G. Shoring and sheeting shall be designed by a Professional Engineer registered in the Commonwealth of Massachusetts and hired by and paid for by the Contractor.

1.12 DRAINAGE

A. The Contractor shall control the grading in areas under construction on the site so that the surface of the ground will properly slope to prevent accumulation of water in excavated areas and adjacent properties.

B. The Contractor shall excavate interceptor swales and ditches, as necessary, prior to the start of major earthmoving operations to insure minimal erosion and to keep areas as free from surface and ponded water as possible.

C. Should surface, rain or groundwater be encountered during the operations, the Contractor shall furnish and operate pumps or other equipment, and provide all necessary piping to keep all excavations clear of water at all times and shall be responsible for any damage to work or adjacent properties for such water. All piping exposed above ground surface for this use, shall be properly covered to allow foot traffic and vehicles to pass without obstruction.

D. Presence of groundwater or stormwater in soil will not constitute a condition for which an increase in the contract price may be made. Under no circumstances place concrete fill, lay piping or install appurtenances in excavation containing free water. Keep utility trenches free of water until pipe joint material has hardened and backfilled to prevent flotation.

E. For further information refer to paragraphs on SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL as specified herein.

1.13 FROST PROTECTION/WORK IN FREEZING WEATHER

A. Protect excavation bottoms and sides against freezing.

B. A layer of fill shall not be left in an uncompacted state at the close of a day's operation when there is the potential for that layer to freeze.

C. The Contractor shall not place any material on snow, ice, frozen soil, or soil that was permitted to freeze prior to compaction. Removal of these unsatisfactory materials will be at the Contractor's expense.

D. Do not excavate to full indicated depth when freezing temperatures may be expected, unless work can be completed to subgrade, the materials installed, and the excavation backfilled the same day. Protect the excavation from frost if placing of materials or backfilling is delayed.

E. The Contractor shall keep the operations under this Contract clear and free of accumulation of snow within the limits of Contract Lines as necessary to carry out the work.

F. No materials shall be installed on frozen ground.

1.14 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Contractor shall take the necessary steps to avoid disturbance of subgrade and underlying natural soils/compacted fill during excavation and filling operations. Methods of excavation and filling operations shall be revised as necessary to avoid

disturbance of the subgrade and underlying natural soils/compacted fill, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials. The Contractor shall coordinate with the Architect or Soils Representative to modify his operations as necessary to minimize disturbance and protect bearing soils, based on the Architect's or Soils Representative's observations.

B. All excavated or filled areas disturbed during construction, all loose or saturated soil, and other areas that will not meet compaction requirements as specified herein shall be removed and replaced with compacted Sand Gravel Fill or Crushed Stone. Fill that cannot be compacted within 48 hours because of its saturated condition shall be removed and replaced with compacted Sand Gravel Fill or Crushed Stone. Costs of removal of disturbed material and replacement with Sand Gravel Fill or Crushed Stone shall be borne by the Contractor.

C. If requested by the Architect, the Contractor shall place a six inch layer of Crushed Stone or 12 inch layer of Granular Fill over natural underlying soil to stabilize areas disturbed during construction.

1. The placement of the Crushed Stone layer or Granular Fill as well as material costs shall be borne by the Contractor.

D. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Architect or the Soils Representative and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall be construed as unsuitable bearing materials. This material shall be removed and replaced with lean concrete, Sand Gravel Fill, or Crushed Stone as directed by the Architect or Soils Representative at no additional cost to the Owner.

1.15 SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL

A. An initial procedure for sequencing of construction operations is specified under Section 31 25 00, EROSION CONTROL. This procedure shall be extended through earthwork operations as follows:

1. Perform initial procedures as specified under Section 31 25 00, EROSION CONTROL – Initial Sequence of Construction Activities and Preliminary Drainage Control.
2. Repair any broken or damaged Sections of the haybales or siltation fencing installed during site preparation and install any additional Sections necessary for proper erosion control.
3. Throughout earthwork operations, in addition to drainage swales, check dams, siltation sumps, and other items shown on the Drawings, the Contractor shall take other necessary precautions, including installation of temporary drainage swales, siltation sumps, check dams, haybales, silt fencing and temporary pipe to direct and control drainage from disturbed areas on the site so that erosion and siltation is minimal. In addition, no erosion or discharge of silt or larger particles shall occur in water bodies or wetland areas to remain undisturbed or onto adjacent properties.
4. Damaged or loose haybales and siltation fence shall be replaced as necessary to maintain their function of controlled erosion and siltation. Damaged or broken down check dams and filtration dams shall be replaced immediately.

5. Throughout construction, remove any accumulation of silt or soil build-up behind haybales, silt fences, check dams and filtration dams as it occurs. Remove accumulations of silt and build-up from the siltation pumps and silt traps when it is approximately 18 inches deep, or when it adversely affects the performance of the system. Remove silt sacks in catch basins when they have become clogged and replace to maintain their function.
6. Replace the crushed stone on the inside of all siltation sumps as necessary to permit adequate flow through the media and to maintain their function as a filter of silt and larger particles. Excavate silt and other material from the basins of all siltation sumps as it accumulates.
7. Remove temporary drainage swales, check dams, siltation sumps, haybales and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed, and grass is established in drainage areas and lawn areas. Do not remove the above items without approval of the Architect. If, in the Architect's opinion, these measures are still necessary, they shall stay in place.

1.16 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the grade and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Building Area: the area defined by the projection of a line from two foot outside of the edge of the footing extending upward and outward at a slope of 1.5H: 1V. (If overexcavation is required below the footing the building area will be redefined from the bottom of overexcavation)

F. Compaction: The tamping and rolling of all backfill placed in uniform horizontal layers not exceeding a defined uncompacted lift thickness.

G. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

H. Deleterious Material: Trash, debris, clay, topsoil, roots, organic material friable, glass, or otherwise degradable materials that compromise the strength and properties of soils.

I. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated. Excavation is unclassified.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

J. Fill: Soil materials used to raise existing grades or meet proposed grades.

K. Frost Zone: The area within 4 feet of finished grade.

L. Influence Area: The area below a footing defined by the projection of a line from two foot outside of either edge of the footing extending downward and outward at a slope of 1V:1H.

M. "In-the-dry": In-situ soil moisture content of no more than two percentage points above the optimum moisture content for that soil.

N. Optimum Moisture Content: Determined by the ASTM standard specified to determine the maximum dry density for relative compaction.

O. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.

P. Proof-rolling: The tamping and rolling of all subgrades.

Q. Relative Density: As defined by ASTM D4253 or D4254.

R. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversized material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Architect.

S. State Standards: Massachusetts Highway Department Standard Specifications for Highways and Bridges.

T. 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.

U. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

V. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

W. Unclassified Excavation: The nature of materials to be encountered has not been identified or described herein.

X. Unsuitable material: Material containing vegetation or organic material, such as mulch, peat, organic silt, topsoil, sod, deleterious material, and/or particles greater than the maximum specified diameter for that materials specific application, that are not satisfactory for use as determined by the Architect.

Y. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.17 REFERENCES

A. American Society of Testing and Materials Publications

B. Massachusetts Highway Department Standard Specifications for Highways and Bridges.

C. City of Beverly Rules and Regulations- Paving Requirements

D. City of Beverly Rules and Regulations- Opening of Streets and Sidewalks

1.18 SUBMITTALS

A. Product Data: For the following:
   1. Each type of plastic warning tape.
   2. Geotextile.
   3. Controlled low-strength material, including design mixture.

B. The Contractor shall submit under provisions of Section 01 33 00, the name of imported material suppliers. Change of source suppliers shall require approval from the Architect.

C. Grain-size distribution analysis test data shall be delivered with the samples. The analysis shall be performed in accordance with ASTM D 422.

D. The Contractor shall submit to the Architect, under provisions of Section 01 33 00, manufacturer's literature and data on proposed compaction equipment.

E. The Contractor shall provide to the Architect, on a daily basis, copies of field records documenting the location of stockpiled material, and stockpile identification data.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each onsite and borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

G. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

H. Contractor shall submit designs for any required or anticipated temporary earth support and/or dewatering systems designed and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts.

1.19 SAMPLING AND TESTING

A. A 50-lb. Sample of each off-site material proposed for use, and of any on-site material when so requested by the Architect or Soils Representative, shall be submitted for approval.
   1. Samples shall be delivered to the office of the Architect or as directed.

2. Samples required in connection with compaction tests will be taken and transported by the Soils Representative.

B. Product Data: Submit location of pits for borrow material.

C. Samples shall be representative of the source pit. If materials are found to vary once construction begins, the Contractor will be required to submit additional representative samples at his own cost.

D. Materials imported to the site by the Contractor for on-site use shall not contain oil, hazardous waste, or deleterious materials.

1. The Contractor shall be responsible for all costs incurred by the Owner as a result of the Contractor's action to import materials containing concentrations of oil and/or hazardous materials to the site.
2. In the event that site characterization of off-site borrow sources indicates that soils are acceptable to the Architect or Engineer for use, than chemical testing will not be required. It is anticipated that chemical testing would not normally be required for material from customarily utilized commercial borrow sources.

   No fill material from "urban areas" will be accepted for fill at the site, even if chemical testing indicates no exceedances of "Reportable Concentrations".

   If requested by the Owner or Engineer, based on review of the borrow site characterization, the Contractor shall conduct testing on proposed fill material and submit results prior to delivery to the site, at no additional cost to the Owner. Testing shall be conducted by a DEP-certified testing laboratory and shall include, at a minimum, the following analytical test data.

   a. Total Petroleum Hydrocarbons (EPA Method 418.1) every 100 yards
   b. Volatile Organic Compounds (EPA Method 8420) every 500 yards
   c. PCB and Pesticides (EPA Method 8080) every 500 yards
   d. Total RCRA Metals (EPA Method 6000-7000 series) every 500 yards
   e. Polynuclear Aromatic Hydrocarbons (EPA Method 8270) every 500 yards
   f. TCLP for those total parameters which exceed twenty times the TCP criteria every 500 yards
   g. Total cyanide (EPA 9020)
3. All off-site material submitted for use on the project site shall conform to the S-1 Soils Standards contained in the Massachusetts Contingency Plan, dated October 1, 1993, Section 310 CMR 40.0975 or site soil background levels, whichever is lower. Samples will be chemically tested to determine their conformance with the S-1 Soils Standards and site soil background levels.
4. Testing parameters and testing frequencies may be reduced, as directed by the Soils Representative.
5. All sieve analyses for conformance of on-site and off-site fill materials to be used in the work shall be done by means of a mechanical wet sieve analysis and in accordance with ASTM D 422.

1.20 QUALITY ASSURANCE

A. The Engineer's duties do not include the supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Engineer

nor any observation and testing by the Engineer shall excuse the contractor from defects discovered in his Work at that time or subsequent to the testing.

B. Subgrades shall be approved for compactness and material composition by the Architect prior to placing subsequent lifts. If inspections indicate Work does not meet specified requirements, the Work shall be removed, replaced and compacted at no additional cost to the owner or architect.

C. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

D. Contractor shall notify Architect when excavations have reached required subgrade and provide a minimum notice of 24 hours prior to placement of backfill on exposed subgrade.

1.21 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact a utility-locator service for the area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and City of Beverly to shut off services if lines are active.

C. Subsurface investigations indicated the presence of fill material which contains organic matter. This material has limited reuse applications at the site.

D. All fill to be removed from the Building Area and Influence Zone as presented on the plans and described herein.

E. Subsurface investigations indicated the presence of sandy materials which will likely be easily disturbed due to construction activities. This material is also likely to require regular moisture conditioning to obtain required compaction requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Segregate excavated material based upon material type to enable reuse in appropriate locations based upon material type.

B. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

2.2 SOIL MATERIALS

A. Satisfactory Soils: All soil shall be ASTM D 2487 Soil Classification Group SP, SW or a combination having gradations as specified herein in the following Sections.

B. Fill material will not be accepted from off-site borrow sources that are Massachusetts DEP MCP disposal sites. Common borrow material obtained from off-site borrow sources that have no known releases or disposal of oil and/or hazardous material shall be acceptable for use only when accompanied by documentation stating there has been no known releases or disposal of oil and/or hazardous materials at the off-site borrow site.

2.3 STRUCTURAL FILL

A. Structural fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Structural Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
3 inches	100
1 ½ inch	80 – 100
½ inch	50 – 100
No. 4	30 – 85
No. 20	15 – 60
No. 60	5 – 35
No. 200*	0 - 10

*0 – 5 Under sidewalks

2.4 ORDINARY FILL

A. Ordinary Fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Ordinary Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture content s within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
6 inches	100
1 inch	50 – 100
No. 4	20 - 100
No. 20	10 - 70
No. 60	5 – 45
No. 200	0 - 20

2.5 COMMON BORROW

A. Common Borrow material shall be soil containing no stone larger than 8 inches and shall be substantially free of organic loam, wood, trash, or other objectionable materials which may be decomposable, compressible or which cannot be properly compacted. Common Borrow materials shall not contain more than 30 percent by weight of silt and clay.

1. No Common Borrow shall be imported until available onsite Ordinary Fill has been utilized or with prior written approval from the Architect.
2. Common Borrow material from off-site borrow sources shall contain not detectable concentrations of asbestos.
3. Common Borrow to be placed within 10 inches of athletic fields shall be soil containing no stone larger than 3 inches and shall meet all other requirements listed herein.

2.6 GRAVEL BORROW

A. Granular Fill shall be onsite or imported material conforming to Item M1.03.0 type a or b of the State Standards.

B. Sand Gravel Fill shall be onsite or imported material conforming to Item M1.03.0 type b of the State Standards.

C. Gravel Borrow materials are not anticipated to be present onsite.

2.7 BEDDING MATERIAL

A. Gravel Borrow Bedding Material shall be imported material conforming to Item M1.03.0 type c of the State Standards.

B. Crushed Stone Bedding Material shall be imported material conforming to Item M2.01.3 of the State Standards.

C. Coarse Sand Bedding Material shall be imported material conforming to Item M1.04.0 type A of the State Standards.

D. Dense Grade Crushed Stone shall be imported material conforming to Item M2.01.7 of the State Standards.

2.8 CRUSHED STONE

A. Crushed Stone shall be impacted durable material with maximum of 1 ½ ” or 2” as specified in the Drawings. Stone used for drainage components shall be double washed. For all other applications fines shall be <1% unless otherwise noted. Crushed stone shall meet the following gradation:

Size (inches)	Percent Finer
1 ½” – 2”	100%
1 ¼”	85% - 100%
¾”	10% - 40%
½”	0% - 8%
#200	< 1%

B. 3/4” Crushed Stone shall comply with State Standards M2.01.4.

C. 1/4” to 3/8” Crushed Stone shall comply with State Standards M2.01.6.

2.9 PEA GRAVEL

A. Clean naturally rounded aggregate with particle sizes no larger than 3/4 of an inch with no more than 5% passing the #8 sieve. The dry density shall be a minimum of 95 pounds per cubic foot.

2.10 GEOTEXTILE FABRIC

A. Geotextile No. 1: Geotextile Fabric for erosion control/slope protection shall conform to Item M9.50.0 type IV of the State Standards. Geotextile No. 1 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	**Test Method**	**Unit**	**Minimum Average Roll Value**
Grab Tensile Strength	ASTM D 4632-91	lbs	120
Grab Tensile Elongation	ASTM D 4632-91	%	50
Trapezoid Tear Strength	ASTM D 4533-91	lbs	50
Mullen Burst Strength	ASTM D 3786-87	psi	225
Puncture Strength	ASTM D 4833-00	lbs	65
Apparent Opening Size (AOS)	ASTM D 4751-99A	U.S. Sieve	70
Permittivity	ASTM D 4491-99A	sec^{-1}	1.8
Permeability	ASTM D 4491-99A	sec	0.21
Flow Rate	ASTM D 4491-99A	gal/min/ft	135
UV Resistance (at 500 hours)	ASTM D 4355-02	% strength retained	70

Physical Properties	**Test Method**	**Unit**	**Typical Value**
Weight	ASTM D 5261-92	oz/yd	4.8
Thickness	ASTM D 5199-01	mils	55
Roll Dimensions (width x length)	--	ft	12.5 x 360 / 15 x 360
Roll Area	--	yd	500 / 600
Estimated Roll Weight	--	lb	164 / 197

B. Geotextile No. 2: Geotextile No. 2 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632	lbs	160
Grab Tensile Elongation	ASTM D 4632	%	50
Trapezoid Tear Strength	ASTM D 4533	lbs	60
Mullen Burst Strength	ASTM D 3786	psi	305
Puncture Strength	ASTM D 4833	lbs	95
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	70
Permittivity	ASTM D 4491	sec^{-1}	1.4
Permeability	ASTM D 4491	sec	0.22
Flow Rate	ASTM D 4491	gal/min/ft	110
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	oz/yd	6.4
Thickness	ASTM D 5199	mils	75
Roll Dimensions (width x length)	--	ft	15 x 300
Roll Area	--	yd	500
Estimated Roll Weight	--	lb	217

C. Geotextile No. 3: Geotextile for the installation of underground tank

1. Woven geotextile fabric with a minimum grab tensile strength of 120 lbs/inch and a maximum apparent opening size of #50 US sieve (0.300 mm)

2.11 OTHER SOIL MATERIAL

A. Drainage Aggregate: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

B. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.

C. Fine Aggregate: ASTM C 33; fine aggregate, natural, or manufactured sand.

D. River Stone: River stone shall be 1 ½" – 3" rounded, smooth stone, color shall be tan-beige range. Contractor to submit 5 gallon container sample with source indicated.

E. Rip-rap: rip-rap shall be sound, durable rock which is angular in shape in accordance with M2.02.0 of the State Specifications.

2.12 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:

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 GENERAL

A. Prior to commencing work, the Contractor shall establish property line locations and place construction control markers clearly visible and understandable to workers in the field. The Contractor shall exercise due care so as not to disturb adjacent structures and shall leave the Site in clean and orderly condition upon completion of the work.

B. Unanticipated Soil Conditions:

1. If unsuitable bearing materials are encountered at the specified subgrade depths, the Contractor shall notify the Architect. The Contractor shall carry excavation deeper and replace the excavated material with compacted fill or concrete as directed by the Architect or Soils Representative.
2. Removal of such material and its replacement as directed will be paid an extra compensation in quantity approved by the Architect. Only changes in the work authorize in advance by the Architect in writing shall constitute an adjustment in the Contract Price.
3. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Architect or the Soils Representative and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall not be construed as unsuitable bearing materials. This material shall be removed

and replaced with lean concrete or compacted Gravel Borrow as directed by the Architect or Soils Representative at no additional cost to the Owner.

4. The Contractor shall follow a construction procedure which permits visual identification of firm natural ground.

C. Excessive Excavation: If any part of the general or trench excavation is carried, through error, beyond the depth and dimensions indicated on the Drawings or called for in the Specifications, the Contractor at his own expense, shall furnish and install compacted gravel fill, concrete, or take other remedial measures as directed by the Architect to bring fill material up to the required level or dimension.

D. Reuse of onsite material: Not all of the materials onsite will be suitable for reuse in all areas of the site. Imported materials are anticipated to meet all of the materials required as described above.

1. Samples and Testing:
2. Excavated material taken directly from on-site cuts that will meet the Specifications may be used as fill provided the Contractor obtains written approval from the Architect. No such fill material shall be put in place until approved for use by the Architect in writing. Sand Gravel Fill is not anticipated to be found on the site.
3. Testing of materials as delivered may be made from time to time. Materials in question may not be used, pending test results. Tests of compacted materials will be made regularly. Remove rejected materials and replace with new, whether in stockpiles or in place.

E. Deficiency of Fill Material: Provide required additional fill material to complete the work if a sufficient quantity of suitable material is not available from the required excavation on the project site at no additional cost to the Owner.

F. Surplus Fill Material: Surplus fill that is not required to fulfill the requirements of the Contract shall be removed from the site and legally disposed of.

3.2 PREPARATION

A. The Contractor shall be deemed to have inspected the Site and satisfied himself/herself as to actual grades and levels and true conditions under which the Work will be performed.

B. Areas required for execution of Work shall be cleared. The work area shall be free of standing water and shall be dry.

C. All site health and safety controls shall be fully established and in operation prior to beginning any demolition, soil, and fill excavation. Site controls shall include but not be limited to work zones properly barricaded, wheel wash and decontamination facilities, and all support equipment and supplies including personal protective equipment. All site controls shall be reviewed by the Architect in the field.

D. The Contractor shall provide all layout field data, including ties, to the Architect. The Contractor shall maintain all required field controls throughout the performance of the Work.

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

F. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 31 10 00 Site and Preparation Clearing."

G. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section 31 10 00," during earthwork operations.

H. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 BUILDING PAD PREPARATION

A. Contractor shall excavate from within the Building Area and Influence Area all unsuitable soils to a depth sufficient to reach the native soils as specified herein, within the geotechnical report, and within the contract plans. Note this may require excavation below footing subgrade as specified herein, within the geotechnical report, and within the contract plans

B. All excavated materials shall be segregated such that reusable material meeting the gradations provided for above are separated from organics and all other deleterious material.

C. Once the final subgrade has been reached, and upon acceptance by the Architect and Soils Representative, Contractor shall backfill the excavated area with Structural Fill in the influence zone of building areas and Ordinary Fill in paved areas. Excavation is anticipated to extend up to 15’ in the western portion of the building. Limits of excavation shall be determined in the field based upon observed conditions.

D. Structural Fill shall be placed within 1 foot of the bottom of all footings and slabs as structural bedding. NOTE: NOT ALL EXCAVATED MATERIAL WILL MEET THE GRADATIONS FOR GRANULAR FILL AND STRUCTURAL FILL.

3.4 PROOF COMPACTING

A. Areas requiring excavation shall be excavated to subgrade and then proof compacted as specified in Section 1.2 of this Specification Section.

B. Where soft zones are revealed by compaction efforts and where organic soil is exposed, the soft material or organic soil shall be removed and replaced with Structural Fill in the influence zone of building areas and utility trenches and Ordinary Fill in paved areas.

3.5 EXCAVATION, GENERAL

A. The Contractor shall remain responsible for adequacy and safety of construction means, methods and techniques.

B. The Contractor shall complete all excavations regardless of the type, nature or condition of the material encountered. The Contractor shall be solely responsible for making all excavations in a safe manner.

C. The Architect shall be notified of unexpected subsurface conditions. Work shall be discontinued in affected areas until notified to resume work by the Architect.

D. Displaced or loose soil shall be prevented from falling into any excavation. The stability of soil slopes shall be maintained in accordance with applicable local, state and federal regulations and guidelines.

E. All loose material shall be removed from the bottom of the excavation so that the bottom shall be in an undisturbed condition. If removal of the loose material results in excavation beyond the work limits and over excavation has not been approved by the Architect; the restoration of the excavation to grade shall be done at no additional cost to the Architect.

F. When the bottom of the excavation shall, by error of the Contractor, have been taken to a depth greater than the depth specified, or directed by the Architect, said condition shall be corrected by refilling to the proper grade with granular fill or the design shall be altered in a fashion acceptable to the Architect to compensate for said error. All measures taken to rectify conditions caused by over excavation shall have the Architect's approval, and any increase in cost resulting from such measures shall be borne by the Contractor.

G. Excavation shall not be performed when weather conditions or the conditions of the materials are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

H. Appropriate measures shall be provided to retain excavation sidewalls and to ensure that persons working in or near the excavation are protected. Sheeting shoring or bracing may be used to support the walls of excavations. Method, design, construction and adequacy of any required bracing shall meet the OSHA requirements of 29 CFR Part 1926 and are the responsibility of the Contractor.

I. All damage related to or caused by the excavation shall be repaired at the expense of the Contractor.

J. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    a. 6 inches beneath pipe in trenches, and
    b. The greater of 18 inches wider than pipe or 36 inches wide.

K. The Contractor shall excavate soil and fill to the limits necessary to achieve the required grades determined by the Architect. The limits of excavation may not coincide with those areas indicated on the Drawings. The excavation areas shown on the Drawings are estimated areas only.

L. If unanticipated bearing soils are encountered beyond the limits of excavation as specified on the Drawings and in the Specifications and at the specified subgrade

depth, the Contractor shall notify the Owner's Representative in writing. The Contractor shall carry the excavation deeper and replace the excavated material with appropriate specified material or concrete as directed by the Architect or Engineer.

M. Removal of topsoil, subsoil, rock, boulder, and organic silt, or silty sand as specified herein and in the Geotechnical Report will not be considered as unanticipated, unsuitable soil conditions at an elevation above specified subgrade elevations. Similarly removal of these materials within paved areas as specified herein will not be considered unanticipated unsuitable soil conditions. Proposed overexcavation as shown on the plans will not be considered unanticipated soil conditions.

N. Unsuitable Soil Allowance: The Contractor shall carry in the base bid 1000 cu. yds. for removal of unanticipated, unsuitable soil materials which become soft as a result of wet weather conditions or demolition activities beyond the subgrade limits shown on all contract drawings and defined within the specification. Allowance shall cover removal and disposal of unsuitable soil and furnishing imported suitable backfill materials compacted in place as directed herein. The base bid shall cover all costs related to such excavation, removal off site, disposal, and replacement with compacted fill of approved material, overhead, and profit. No amount other than that herein specified will be paid by the Owner for excavated defined herein.

1. If the total void volume of unanticipated unsuitable material excavation below specified subgrades, and its replacement with compacted fill exceeds the amount included in the Contract as listed above, the Owner shall pay the excess excavation and replacement at the unit price of $35.00 per cubic yard.
2. If the total quantity of unanticipated unsuitable materials below specified subgrades, and its replacement with compacted fill is less than the amount included in the Contract as listed above, the contract sum will be decreased by the difference in excavation and its replacement multiplied by the unit price of $30.00 per cubic yard.
3. Final excavated surfaces shall be surveyed by the Contractor and shall be measured from specified subgrade to bottom of excavation. Payment shall be based upon actual volumes with no bulking or swell factors applied. Contractor shall submit all survey data and quantity calculations to Architect for approval.

3.6 ROCK EXCAVATION

A. Definitions and Classifications: The following classifications of excavation will be made only when rock excavation is required.

1. "Earth Excavation" consists of removal and disposal of pavement and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on subsurface conditions, and other materials encountered that are not classified as rock excavation.
2. "Rock Excavation" consists of removal and disposal of materials encountered that cannot be excavated without continuous and systematic drilling and blasting or continuous use of a ripper or other special equipment, except such materials that are classed as earth excavation. Typical of materials classified as rock excavation are as follows:
   a. Rock or stone in original ledge.
   b. Hard shale in original ledge.

c. Boulders on site, outside trench limits, exceeding three cubic yards in volume.

d. Boulders within trench limits, exceeding one cubic yard in volume.

3. Should highly fractured or weathered bedrock be encountered during excavation, the following shall apply:

   a. When the material is encountered in trenching operations or under footings, it shall be excavated or ripped with a hydraulic backhoe equal to or larger than Caterpillar 225 backhoe, and will be classified as Earth Excavation. When it is demonstrated to the satisfaction of the Architect and the Soils Representative that this material can no longer be removed with a hydraulic backhoe and requires drilling and blasting, this material shall be classified as Rock Excavation. For excavation procedures when this material is encountered under footings, refer to paragraph below.

   b. When this material is encountered in open excavation, it shall be classified as earth excavation until drilling and blasting or continuous ripping is necessary as defined hereinabove.

4. Intermittent drilling and ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

5. Allowance for Rock Excavation: The Contractor shall carry in the Base Bid an allowance for 10 cubic yards or rock encountered in trench excavation removed from the site. The Contractor shall also carry in the Base Bid an allowance of 10 cubic yards of open rock excavation removed from the site. The Base Bid shall cover all costs relating to such rock excavation, including blasting, removal and placement of the excavated material, overhead and profit. No amount other than that herein specified will be paid by the Owner for excavation herein defined.

   a. If the total quantity of Rock Excavation, open and/or trench, exceeds the amount of Rock Excavation included in the Contract as listed above, the Owner shall pay the excess excavation at the unit price submitted in the Bid Form.

   b. If the total quantity of Rock Excavation, open and/or trench, is less than the amount of Rock Excavation included in the Contract as listed above, the Contract sum will be decreased by the difference in Rock Excavation multiplied by the unit price submitted in the Bid Form.

B. Measurements:

1. When, during the process of excavation, rock is encountered, such material shall be uncovered and exposed in such a manner that the unbroken ledge surface is clearly visible, and the Architect shall be notified by the Contractor, before proceeding further. The areas in question shall then be cross-sectioned as hereinafter specified.

2. Failure on the part of the Contractor to uncover such material and to notify the Architect and proceeding by the Contractor with the rock excavation before cross-sections are taken, will forfeit the Contractor's right of claim towards the stated allowance or additional payment over and above the stated allowance at the quoted unit price.

3. The Contractor shall employ and pay for a Professional Civil Engineer or Land Surveyor registered in the Commonwealth of Massachusetts to take cross-sections of rock before removal and to make computations of volume of rock

encountered within the Payment Lines. Cross-sections shall be taken in the presence of the Soils Representative and the computations approved by the Architect. The Owner has the option to perform independent cross-sections and computation of rock quantities.

4. Where removal of boulder or ledge is required outside the established payment lines, the extent of this removal and basis of payment shall be determined by the Architect.

C. If ledge is encountered within the limits of the Proposed Building Area, the Contractor shall excavate this material 18 inches below subgrade of footings and 12 inches below subgrade of slabs unless otherwise directed by the Architect or Soils Representative. All loose or shaken rock shall be removed and replaced with compacted gravel fill, crushed stone or lean concrete as directed by the Soils Representative.

D. Rock excavation for foundations outside of the Building Area: Remove rock to foundation or footing subgrade. All rock bottoms for foundations shall be carefully examined. Loose or shaken rock shall be removed to solid bearing, and the rock surface leveled, or shelved to a slope not exceeding one inch per two feet, or as directed.

E. Excavate rock encountered in grading under paved areas, lawns and plant beds to subgrade as specified herein and shown on the Drawings. All boulders or protruding rock outcrops shall remain undisturbed at lawns and plant beds when so directed by the Architect. Rock shall be fractured six inches below subgrade of paved areas but this six-inch layer shall remain in place. Rock in lawns and plant beds shall be similarly treated unless it is directed to remain.

F. Prepared rock subgrades shall be compacted with at least four passes of a self-propelled vibratory roller such as Dyna Pac CA-30D (44,000 lbs. Centrifugal force) or equivalent. Rock subgrades in utility trenches shall be recompacted with at least four passes a walk-behind vibratory drum roller or other equivalent equipment having at least 10,000 pounds centrifugal force and sufficient to provide a firm, stable subgrade.

G. If any part of the rock excavation at footings to be carried beyond the depth and the dimensions indicated on the Drawings or called for in the Specifications, the Contractor shall, at his own expense, furnish and install concrete of same strength as footings to the required subgrade level of the footings as shown on the Drawings. Dowelling or other corrective structural measures as directed by the Architect may also be required to properly anchor or reinforce the concrete. If rock excavation is carried beyond the depth and dimensions to subgrade in other areas, the Contractor shall, at his own expense, furnish and install compacted gravel fill to subgrade as directed by the Architect.

H. Basis of Payment: The total amount of rock excavation will be based upon the in-situ volume of rock excavated within and/or above the lines referred to in the next paragraph as “Payment Lines”. The payment lines are only to be used as a basis of payment, and are not to be used as limits of excavation. Limits of excavation area as shown on the Drawings and as specified herein.

I. Payment Lines for Rock Excavation:

1. Payment lines for columns and footings within the building shall be a vertical line one-foot off the edge of the footings; the depth shall be measured at 24 inches below the bottom elevations shown on the Drawings. If rock is to remain directly below the bottom of the footings within the Building Area, payment lines shall be six inches below the bottom elevation of the footing as shown on the Drawings. Payment lines for walls to be damp-proofed shall be a vertical line two feet outside the walls. Payment lines for footings outside of the building shall be six inches below the bottom of footings. Vertical payment lines shall be as specified hereinafter.
2. Payment lines for manholes and catch basins shall be one-foot outside of the outer wall and six inches below subgrade beneath the structure.
3. Payment lines for rock excavation under slabs on grade shall be six inches below the bottom elevation of the specified gravel base course outside of the building and 12 inches below subgrade for slabs within the building. Payment lines for rock excavation at plant beds shall be 12” at edge and full depth of required elevation for loam.
4. Payment lines for rock excavation at paved areas and lawns shall be six inches below respective subgrades.
5. Payment lines for rock excavation under pipes within the building and for utility trenches outside the building lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus two feet for pipes up to 18 inches. For pipes 18 inches and larger payment lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus three feet. Payment lines at bottom of all pipe and utility trenches shall be six inches below subgrade.

3.7 STORAGE OF SOIL MATERIALS - STOCKPILING

A. The Contractor shall be responsible for managing and tracking any and all materials excavated and placed in stockpiles for testing.

B. Materials shall be stockpiled on site at locations proposed by the Contractor and approved by the Architect. Stockpiled materials shall be of sufficient quantities to meet project schedule and requirements

C. Tracking of the stockpiles shall be performed in accordance with the approved Work Plan submitted by the Contract in accordance with Section 01 33 00.

D. The temporary stockpiled fill must be removed from the Site in accordance with applicable regulatory deadlines however no later than the completion date of this contract or 90 days from the date the stockpile was created, whichever is encountered first.

E. Stockpiles shall be securely barricaded and clearly labeled. Differing materials shall be separated with dividers or stockpiled apart to prevent mixing.

F. The Contractor shall direct surface water away from stockpile site to prevent erosion or deterioration of materials. Soils shall be suitably dewatered prior to their relocation on Site or disposal off site.

G. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.9 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Trenches shall be excavated to the necessary width and depth for proper laying of pipe or other utility and excavation side slopes shall conform to OSHA requirements. Minimum width of trenches shall provide clearance between the sides of the trench and the outside face of the utility. Maximum trench sizes are as shown on the Drawings or as specified herein. The depth of the trench shall be six inches below the bottom of the pipe barrel or respective utility. If the existing soil at the final subgrade excavation is found not suitable, the Architect or Soils Representative may approve removal and replacement of material.

1. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
2. Clearance: As indicated on plans.
3. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

C. The Contractor shall provide, at his own expense, suitable bridges over trenches where required for accommodation and safety of the traveling public and as necessary to satisfy the required permits and codes.

3.10 SUBGRADE INSPECTION, COMPACTION AND PROOF ROLLING

A. Notify Architect when excavations have reached required subgrade.

B. Proof compact all subgrades in accordance with Subsection 1.2 of this Specification Section and the Geotechnical Report to identify soft pockets and areas of excess yielding. Do not proof compact wet or saturated subgrades.

1. Completely proof compact subgrade in one direction repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect and/or Soil Representative, and replace with compacted fill as directed.
3. Proof compacting shall be completed utilizing a 20-Ton vibratory drum roller for granular soils. Should clay or other cohesive soils be encountered, sheep's foot roller shall be utilized. A total of 6 passes shall be considered complete.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect and/or soil representative, without additional compensation.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage,
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.

B. If, through failure or neglect of the Contractor to conduct the excavation work in a proper manner, the surface of the subgrade is in an unsuitable condition for proceeding with construction, the Contractor shall, at his own expense, remove the unsuitable material and replace it. Failure of the Contractor to control surface or ground water adequately, premature excavation at the work site, or other manifestations of the Contractor's neglect or improper conduct of the work, as determined by the Architect, shall be grounds for requiring removal and replacement of unsuitable subgrade without additional compensation.

C. Grading in the vicinity of backfilling shall be properly pitched to prevent water from running into the backfilled area. Work areas shall be kept free from water during performance of the work under this Contract at no expense to the Architect. The Contractor shall build diversion berms and other devices necessary for this purpose.

D. The Contractor shall not commence backfilling operations until the Architect gives approval.

E. After the subgrade has been prepared, fill material shall be placed and built-up in successive layers until the required elevations are reached. No fill shall be placed on a frozen surface, nor shall snow, ice, or other frozen material be included in fill. Wet materials containing moisture in excess of the amount necessary for satisfactory placement or compaction shall not be used.

F. All fill shall be brought up in essentially level lifts and shall be placed in levels by standard methods. The method of placement shall not disturb or damage other work. Layers of fill shall not exceed twelve inches of uncompacted thickness before compaction, unless otherwise specified or as necessary for proper subgrade stabilization.

G. Place backfill on subgrades free of mud, frost, snow, or ice.

H. Filling operations shall continue until the fill has been brought up to the finished slopes, lines, and grades making proper allowances for thickness of surface treatment.

I. The entire surface of the work shall be maintained free from ruts and in a condition that will permit construction equipment to travel readily over any Section. The top

surface of each layer shall be made level or slightly sloped away from the center of the filled area. Fills should be graded to drain and compacted/sealed whenever precipitation is expected.

J. Backfilling shall not be performed when weather conditions or the conditions of the material are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

3.12 ACCEPTABLE BACKFILL MATERIALS

A. Backfill materials shall be placed in the areas as indicated in the table below:

Fill at depths greater than 1-foot below footings and slabs within the Building Area	Structural Fill (Geotech Report)
Fill around footings for building and structures within the Influence Area	Structural Fill (Geotech Report)
Fill below pavement subgrade elevation	Ordinary Fill (Geotech Report)
Fill below sidewalk subgrade elevation	Ordinary Fill (Geotech Report)
Fill within utility trenches below pavement and sidewalk subgrade	Granular Fill
Fill below utility bedding	Granular Fill
Fill placed 6 inches below footings	Structural Fill (Geotech Report)
Fill placed 1 foot below slabs	Structural Fill (Geotech Report)
Fill placed in landscaped areas outside of the Influence Area	Common Borrow

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.14 BELOW GRADE TANK BACKFILL

A. Backfill with Pea Gravel as specified in paragraph 2.9 of this section. The manufacturer has indicated that the use of the proper material is critical to the long term tank performance.

B. Do not mix approved backfill material with sand or native materials. Do not backfill tank with sand or native materials.

C. Replace all excavated native materials with approved Pea Gravel which meets ASTM C 33 for quality and soundness.

3.15 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

1. Sequentially place and compact fill material in layers to required elevations.

B. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by +2 to -3 percent and is too wet to compact to specified dry unit weight.
3. If in the opinion of the Architect, additional moisture is required, water shall be applied by sprinkler tanks or other uniform distribution devises. If excessive amounts of water or if rain should cause excessive wetness, the area shall be allowed to dry as provided above.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross Sections, lines, and elevations indicated. Grading shall be done by standard methods. Areas adjacent to structures and other areas inaccessible to heavy grading equipment shall be graded by manual methods. Embankments shall be graded at all times to ensure runoff of water.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Provide proper drainage from the site, no grading shall be done to direct water to damage or potentially damage adjacent property or work executed under this contract.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus [**1 inch**]
2. Walks: Plus or minus [**1 inch**]
3. Pavements: Plus or minus [**1/2 inch**]

3.18 FIELD QUALITY CONTROL

A. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed in accordance with Subsection 1.7 of this Specification Section and:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every **500 sq. ft.** or less of paved area, but in no case fewer than 3 tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each **150 feet** or less of trench length, but no fewer than 2 tests.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.19 COMPACTION REQUIREMENTS

A. The following table lists minimum compactive efforts, which are required for all, fill materials. Compaction of each lift shall be completed before placement and compaction of the next lift is started. The compaction equipment shall make an equal numbers of transverse and longitudinal coverages of each lift. The degree of compaction for fill placed in various areas shall be as follows:

1.	Under concrete slabs and footings	95%
2.	In paved areas	
	Within aggregate base course	95%
	Within aggregate subbase course	95%
	Below subbase course	92%
3.	In landscaped areas	90%
4.	Around and Above Utilities below	
	Below Pavement subbase in paved areas	92%

*Percentage of maximum dry density of the materials at optimum moisture content as determined by methods or tests for ASTM designation D1551 Method D.

B. Compaction shall be accomplished by vibratory rollers, multiple wheel pneumatic tired rollers or other types of approved compacting equipment. Loaded trucks, low beds, water wagons and the like shall not be considered as acceptable compaction equipment unless specifically approved by the Architect for a particular location. Equipment shall be of any such design that it will be able to compact the fill to the

specified density in a reasonable length of time. All compaction equipment shall be subject to the approval of the Architect.

C. The Contractor shall compact all fills made during the day of work prior to leaving the project for the evening. The upper layer shall be pitched as necessary to provide positive drainage towards swales or interceptor ditches to minimize ponding and erosion should it rain.

3.20 COMPACTION TESTING

A. The Contractor shall make all necessary excavations and preparations for testing. Excavations for density tests shall be backfilled with material similar to that excavated, and compacted to the specified density by the Contractor. Failure of the backfill material to achieve the specified density will be just cause for rejection of any or all portions of the excavation Section tested. The Contractor will not be granted an extension of time or additional compensation for testing or repair of backfill ordered by the Architect.

B. Field density tests will be made by the Owner's Inspection Agency in accordance with the Method of Test for ASTM Designation D1556 or D6938, to determine adequacy of compaction; the location and frequency of such field tests shall be at the Architect's Inspection Agency's discretion.

C. All field density tests results shall be reviewed by the Architect prior to the placement of concrete.

D. The Contractor shall notify the Inspection Agency when an area is ready for compaction testing. This notification shall be 48 hours in advance of placing or final compaction so that the Architect Inspection Agency has adequate time to take compaction tests.

E. Cooperate with the Architect in obtaining field samples of in-place materials after compaction. Furnish incidental field labor in connection with these tests. The Contractor will be informed by the Architect of areas of unsatisfactory density which may require improvements by removal and replacement, or by scarifying, aerating, sprinkling (as needed), and recompaction prior to the placement of the new lift. No additional compensation shall be paid for work required to achieve proper compaction.

F. The Owner or Architect's Inspection Agency's presence does not include supervision or direction of the actual work by the Contractor, his employees, or agents. Neither the presence of the Inspection Agency nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

1. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

B. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

1. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
2. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Project property.

3.23 REMOVAL OF EROSION CONTROL MEASURES

A. Remove temporary drainage swales, check dams, siltation sumps, hay bales, siltation fencing and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed and grass is established in drainage areas leading to siltation sumps. Contractor shall excavate and remove all sediments from siltation sumps prior to backfilling the sumps. Remove erosion control measures when approved by the Architect.

End of Section

Section 311000

SITE PREPARATION AND CLEARING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this trade.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 SCOPE OF WORK

A. This Section includes the following but is not limited to:

1. Removing existing trees, shrubs, groundcovers, plants and grass.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Installation and maintenance of temporary erosion and sedimentation control measures.
6. Removal and disposal of site features at the locations specified on the Drawings and in Section 02 41 00 Site Demolition.

B. Work to be done includes furnishing all labor, materials, equipment and services required to complete all site preparation, erosion control and demolition work indicated on the drawings and as specified herein.

C. Special attention is directed to requirements covering existing site conditions to be protected and preserved in the finished work and to the Initial Sequence of Construction Activities and Preliminary Drainage Control specified herein.

D. It is brought to the Contractor's attention that procedures for drainage, erosion and siltation control specified in this Section and Section 31 25 00 will be controlled by a NPDES General Permit for Construction Activity. The Contractor is responsible for filing the NPDES General Permit for Construction Activity. A copy of Notice of Intent and NOI drawings shall be retained on the site during construction. In addition to this Section, the Contractor shall refer to the General and Supplemental General Conditions and Division 1, General Requirements, for other conditions related to the NPDES Permit. Contractor is required to prepare all necessary documents required for the NPDES Permit including Storm Water Pollution Prevention Plan.

F. Applying for and obtaining an NPDES Permit for General Construction Activity prior to any construction work at the site is the Contractor's responsibility.

1.3 RELATED WORK

A. Division 2 – Section 02 41 00 – Site Demolition.

B. Division 31 – Section 31 00 00 Earthwork for soil materials, excavating, backfilling, and site grading.

C. Division 31 – Section 31 25 00 “Erosion Control” for installation and maintenance of erosion controls, minimization of disturbances to sensitive areas.

D. Division 32 – Section 32 00 00 Bituminous Concrete Paving, Curbing and Edging for placement of vertical granite curing and paving of roadways and walkways.

1.4 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage and/or disturbance to existing adjacent lands beyond the Limit of Work. Actual damage to these areas, caused by the Contractor, shall be repaired to the satisfaction of the Architect, at no additional cost to the owner or architect. Repairs may include pruning or removing damaged vegetation as specified, replacement of damaged vegetation, restoration of the ground plane to its original condition, and any other work required to restore the area to its original condition as depicted in the site photographs taken at the beginning of construction. The project will not be accepted until all repair work is complete.

1.5 PERMITS AND CODES

A. All work shall comply with all codes, rules, regulations, laws and ordinances of the City of Beverly, Commonwealth of Massachusetts, and all other authorities having jurisdiction. All work necessary to make site preparation comply with such requirements shall be provided without additional cost to the Owner.

B. The Contractor shall procure and pay for all permits and licenses required for work under this Section.

C. The Contractor shall not close or obstruct any streets, sidewalks, or passageways, unless and until they have been discontinued by the City or unless and until he shall have first secured all necessary municipal or other permits thereof. No material whatsoever shall be placed or stored in streets or passageways until they have been so discontinued. The Contractor shall conduct their operations to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks, or other facilities near enough to the work to be affected thereby.

D. The procedures for drainage, erosion, and siltation control specified in this Section and Section 312500, are related to procedures required for a NPDES General Permit NOI. In addition to these Sections, the Contractor shall refer to the General and Supplementary General Conditions and Division 1 General Requirements for other conditions related to the NPDES Permit.

E. Issue submittals in accordance with Division 1. Submittals under this Section shall include manufacturer’s specifications and installation instructions.

1.6 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

B. Plans, surveys, measurements and dimensions, under which the work is to be performed, are believed to be correct to the best of the Architect's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

C. Information on the Drawings, Reference Drawings, and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for the information and convenience of the Contractor, and the accuracy or completeness of this information is not guaranteed.

D. Site Information – data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by the Contractor. Data are made available for the convenience of the Contractor. Neither the Owner nor the Soils Representative assumes responsibility for accuracy of the data other than at the particular locations and at the time the explorations were made.

1.7 STAGING AREA

A. No parking is permitted within the right of way of adjacent streets or onsite outside of the limit of work for each phase. The Contractor shall submit a plan for his/her construction staging and equipment storage within the limits of work, prior to commencing construction.

B. No parking of cars or stockpiling of construction materials shall be permitted under any trees that are scheduled to remain or be protected.

1.8 DISPOSITION OF EXISTING UTILITIES

A. Active utilities existing on the site shall be carefully protected from damage and relocated or removed or abandoned as necessitated by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and both Architect and the utility owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Architect.

PART 2 – PRODUCTS

2.1 TREE PROTECTION FENCING

A. Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet (2.4 m) apart.
   a. Height: 4 feet
   b. Color: High-visibility orange, nonfading.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Restrict construction activities to those areas within the limits of construction, public rights-of –way, and easements designated on the Contract Drawings. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored at the Contractor's expense to their original condition, and to the full satisfaction of the property owner.

3.2 SITE CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions, except for those indicated on the Contract Drawings to remain, interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Removal shall include digging out stumps in their entirety and grubbing roots to at least 30 inches below existing or proposed grades, whichever is deeper, as shown on the Contract Drawings.

B. Carefully and cleanly cut roots and branches of existing trees indicated to remain and be protected, where such roots and branches obstruct new construction. Use only hand methods for grubbing inside drip line of trees indicated to be left standing.

C. Clearing shall consist of the felling and disposal of standing trees, and the removal and disposal of all brush, down timber, fences and rubbish. Trees, brush and down timber may be chipped and a portion of the chipped material shall be stockpiled on site in a location selected by the Architect and for dispersion into wooded areas in locations selected by Architect.

D. In all areas that are to be cleared, all brush, grass and other vegetation, except trees, shall be cut off flush with or below the original ground surface.

E. All lines and grade work required for this contract at the site shall be laid out by a registered land surveyor or Professional Engineer employed by the Contractor, in accordance with the Drawings and Specifications.

F. Prior to starting site clearing operations, stake out all roads, edges of parking areas, and other future paved areas as indicated, limits of cut and fill at the edges of

these areas (it limits do not coincide) and areas of trees to be saved as noted on the Drawings.

G. Before any clearing is done, promptly upon completion of layout work, the Contractor shall arrange a conference on the site with the Architect to identify and mark trees and shrubs which are to remain. Adjustments to clearing lines shall be made at this time to save trees or other existing conditions on the edges of clearing lines. If necessary, minor grading adjustments shall be made to save these trees. Do no clearing without clear understanding of existing conditions to be preserved.

H. The owner shall be reimbursed should individual trees, shown on the drawings to be protected, become damaged during the course of the work. All expenses incurred shall be paid by the Contractor without additional cost to the Owner.

The owner shall be reimbursed should trees, which are beyond limits of clearing shown on the drawings or beyond limits of clearing approved by the Architect, be cleared or damaged and are part of larger, contiguous wooded areas.

These damaged trees shall be removed from the site, the stumps grubbed and the ground surface repaired. Costs for this removal shall be borne by the Contractor and not be included as part of the above schedule.

I. Fell trees in such a way as not to injure trees to be saved. Trees shall be cut three feet or less from existing grades. All brush or other material shall be cut flush to the ground. All material from clearing operations shall be chipped or cut into log lengths. All piles of chipped material (except those stockpiled for future inclusion in the work) and logs from clearing operations shall be removed from the site prior to or at the end of the clearing work.

J. Limits of clearing shall be those areas shown on the Drawings with modifications as herein specified. Removal of trees, shrubs and bushes outside these areas shall be done only as noted on Drawings.

K. No trees to be saved shall be used for crane stays, guys or other fastenings. Vehicles shall not be parked nor debris burned where damage may result to trees to be saved. Do not permit heavy equipment, materials or stockpiles within branch spread. Remove interfering branches without injury to trunks and cover scars with wound paint.

3.3 INITIAL SEQUENCE OF CONSTRUCTION ACTIVITIES AND PRELIMINARY DRAINAGE CONTROL

A. Prior to beginning grubbing and topsoil stripping operations, the Contractor shall perform the following sequence of construction operations to minimize erosion and siltation on the lower parts of the site.

1. Prior to grubbing or topsoil stripping, place all haybales, silt fence visual barrier, and catch basin filter fabric protection at the edge of the limits of work and in the location shown on the Drawings. Although installation of these measures can be phased according to the construction schedule, haybales, silt fence and visual barrier must be in place prior to any work in a specific lo-

cation. During grubbing and topsoil operations, extend haybales and silt fence as necessary and maintain these until siltation sumps or other erosion control measures can be constructed. Provide all necessary erosion and siltation control measures to eliminate erosion or siltation from occurring beyond the limits of work.

2. Prior to any earthwork operations, install temporary siltation pumps, filtration dams and swales with check dams in the shown on the Drawings or as otherwise approved by the Architect. Place inlet protection in any downstream catch basins that fall either within the limits of work or beyond the limits of work that will receive silts or sediments from construction operations. These measures may be installed in phases according to the Construction Schedule, but must be completed prior to earthwork operations in the adjacent work area.
3. Should the work require it dewatering trenches, well points, or deep sumps will be required for predrainage of soils in areas where substantial work is to occur below the ground water level. These areas shall be excavated in-the-dry. Construct dewatering trenches, well points, or deep sumps in these areas. Begin immediate pumping of any water buildup in these dewatering trenches or sumps into siltation sumps or other erosion control devices approved by the Architect. During construction and during use of siltation sumps for dewatering, a 12-inch gravel filter shall be placed on the upstream side of the filtration dam. Care shall be taken to pump this water into the siltation sump in such a manner so that water laden with silt and debris will be properly filtered out through the filtration dam and so the gravel filter does not erode from pump water discharge. The gravel filter shall be replaced as necessary when it becomes clogged with silt and debris or does not permit free drainage of water through it to properly maintain its function of filtering out silt and debris. During dewatering, care shall be taken to prevent water from flowing back into the areas being pumped or into adjacent areas. It may be necessary to build a temporary dike around the edges of the siltation sump to prevent water from flowing back into adjacent areas.
4. Begin grubbing and topsoil stripping operations simultaneously with the excavation of the dewatering trenches or deep sumps. It is called to the attention of the Contractor that there are numerous locations within the limits of the work where flowing water will occur during periods of heavy rainfall and from normal rainfall that can be expected during the months that construction will occur. Temporary erosion and siltation control measures will have to be taken during construction to eliminate any erosion and siltation beyond the limits of the work until the permanent measures shown on the Drawings can be installed. All necessary measures shall be taken so this does not occur.
5. Do no grubbing, topsoil stripping or excavation operations in areas where substantial work is to occur below the water table until surface and subsurface water in this area will have drained and soils have reached a stable condition. Prior to beginning the above operations, arrange a meeting with the Architect or his designated representative to observe conditions in this area and discuss methods for proceeding the excavation operations.
6. Damaged or loose haybales and siltation fence shall be replaced as necessary to maintain their function of controlling erosion and siltation. Damaged or broken downs check dams and filtration dams shall be replaced immediately. Catch basin filter fabric protection shall be replaced as necessary to maintain its function of controlling erosion and siltation.

7. Remove any accumulation of silt or soil buildup behind haybales, check dams and filtration dams, as it occurs. Remove accumulations of silt and soil buildup from the siltation sumps, and silt traps. Replace the gravel filter on the inside of the filtration dams when it becomes clogged with silt or does not permit free drainage of storm water through it, whichever occurs first. During freezing weather, ½" crushed stone may be used in lieu of gravel if approved by the Architect. Remove silt sacks under catch basin grates when they become clogged and replace with new ones.
8. Throughout excavation, filling and grading operations, in addition to drainage swales, check dams, siltation sumps, filtration dams and other items shown on the Drawings, the Contractor shall take other necessary precautions, including installation of temporary drainage swales, siltation sumps, filtration dams, check dams, haybales, siltation fence and temporary pipe to direct and control drainage from disturbed areas on the site so that erosion and siltation is minimal. In addition, no erosion or discharge of silt or larger particles shall occur onto adjacent properties.

B. If the Contractor anticipates deviations from the above procedures, he shall notify the Architect or his designated representatives as soon as possible. No substantial deviations from the above sequence of activities shall take place without the Architect's or his designated representative's approval.

C. The Contractor shall maintain these erosion control measures for the duration of this Contract or until they no longer function for their intended purpose, as determined by the Architect.

D. All silt and collected debris shall be removed from the sumps prior to backfilling of these areas.

3.3 GRUBBING

A. Limits of grubbing shall coincide with limits of clearing.

B. Remove completely all stones or surface boulders within the topsoil zone, and stumps, roots, matted roots and brush. Exposed boulders or other materials may be removed contiguous with stumps and matted roots. However, this shall be done in such a manner as not to remove topsoil in the same operation such as using a toothed blade to "rake" stones and stumps from topsoil.

C. Stumps and boulders shall be removed form the site and legally disposed of.

3.4 STRIPPING AND STOCKPILING TOPSOIL AND SUBSOIL

A. Prior to the start of General Excavation, strip all topsoil and subsoil from within areas to be regraded, as shown on the Drawings and stockpile where indicated on the Drawings or remove from the site and stockpile off-site if there is not adequate space in the location indicated on the Drawings. Do no stripping without clear understanding of the existing soil, planting and site conditions to be preserved and limits of existing topsoil stockpile and stripped areas.

B. All topsoil encountered during the stripping operations, regardless of depth, shall be removed and stockpiled on the site as shown on the Drawings or where directed by the Architect or removed from the site if the Contractor determines there is adequate topsoil to complete the work and after approval by the Architect. Areas having greater depths of topsoil than indicated on boring data sheets or reasonably anticipated shall be stripped of all such material and fill shall be used to bring such areas to the rough grade level. Stones over six inches and tree roots over two inches in any dimension shall be removed from loam before stockpiling. All other stripped soil that can be classified as fill as defined in Section 310000, EARTHWORK, shall be stockpiled for reuse in rough grading. This material shall be stripped separately from the topsoil. Topsoil and organic materials due to be stripped are as follows:

1. Building Structures, Roads, Parking Areas, Turf and other site improvements except lawn areas – remove completely.
2. Future Lawn Areas –Topsoil shall be removed from adjacent proposed buildings, structures, site improvements, roads and parking areas a distance equal to the depth of fill plus three feet in the particular location, i.e. for a five foot fill, topsoil shall be removed a minimum of eight feet away from the adjacent site improvements.

C. The Contractor shall so control his topsoil stripping operation so that it does not become contaminated with subsoil or other earth materials; the Contractor shall use machinery suitable for achieving this result.

D. Subsoil: The material directly below the topsoil indicated on the test pit logs as "subsoil" shall not be considered usable as Ordinary Fill as specified in Section 310000, EARTHWORK, or for topsoil. The only area where subsoil may be used is under lawn areas. This material shall be stripped separately from the topsoil and from the underlying earth materials. Subsoil shall be stripped as follows:

1. Building Structures, Roads, Parking Areas, Turf and other site improvements except lawn areas – remove completely.
2. Future Lawn Areas, Sub-soil shall be removed from adjacent proposed buildings, structures, site improvements, roads and parking areas a distance equal to the depth of fill plus three feet in the particular location, i.e. for a five foot fill, topsoil shall be removed a minimum of eight feet away from the adjacent site improvements.

E. All excess subsoil encountered in earthwork operations shall be removed from the site and legally disposed of. Topsoil shall be stockpiled as described hereinabove.

F. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

G. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. The Contractor is responsible for all construction, protection, movement and maintenance of stockpiles. Stockpiles shall be neatly trimmed and graded to provide proper drainage from their surfaces and maintained so as not to erode or pollute their surroundings.

H. The Contractor shall take reasonable care to avoid creating unsightly or unsafe conditions and to avoid unnecessary damage or injury to surroundings.

I. Do not stockpile topsoil within tree protection zones.

J. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

K. Topsoil which has been stripped and stockpiled, but is not needed after the completion of all final topsoil and grassing shall be disposed of offsite. Prior to the disposal of any stockpiled excess topsoil offsite, the Contractor shall offer any excess topsoil to the Architect for their use.

3.5 RESTORATION OF SITE ITEMS

A. Wherever streets, lawns or other items within or outside the Contract Limit Lines have been damaged in fulfilling the work required under this Contract, the Contractor shall furnish and install all material at no cost to the Owner to bring finish surfaces level with the existing adjacent conditions. All work shall be installed to match the existing conditions. Notify the proper authorities, if required, prior to restoring surfaces outside the Contract Limit Lien to assure conformance to existing requirements.

3.6 REMOVAL OF EROSION CONTROL

A. At the time of acceptance of lawns by the Owner, Contractor shall remove all remaining erosion control devices such as silt fence, haybales, and visual barrier and legally dispose of them offsite.

3.7 DISPOSAL OF WASTE MATERIALS

A. Removal from the Subject Property: Remove waste materials and unsuitable and excess topsoil and dispose of offsite in a legal manner. Waste materials shall include but not be limited to timber, brush, refuse, stumps, roots, vines, debris and other objectionable matter. All timber designated in the field by the Architect to not be disposed of by the Contractor shall be stored at a nearby location for ultimate disposal by the Architect.

B. Burning of cleared and grubbed materials or other fires for any reason will not be permitted.

C. No rubbish or debris of any kind shall be buried on the site.

3.8 IDENTIFICATION OF TREES AND SHRUBS TO REMAIN

A. Prior to starting site clearing operations, stake out all areas of trees and shrubs to be saved as noted on the Contract Documents for approval by the Architect.

B. The Contractor shall be responsible for the protection of all existing trees and plants designated to remain for the length of the construction period, including liability for all damages as specified herein. The placement of protection devices additional to those specified shall, however, bet at the Contractor's discretion and with no additional cost to the Architect.

3.9 REFERENCE POINTS

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. The Contractor shall conduct a benchmark survey throughout the Site to verify the accuracy of the benchmarks shown on the Drawings.

C. The Contractor shall install benchmarks prior to commencing work in areas, which will not be disturbed so at any time there is a benchmark within 250 feet of all portions of the work.

3.10 PROTECTION OF EXISTING UTILITIES

A. Protect existing site improvements from damage during construction.

B. Restore damaged improvements to their original condition, as acceptable to the Architect.

C. All areas disturbed through the removal and disposal of existing utilities and site improvements outside the limits of final grading shall be loamed and seeded or paved to match or exceed existing conditions.

D. The Contractor shall protect existing utility poles, overhead wires, and other electrical or communications elements within and adjacent to the property.

E. Any damage to these utilities or structures resulting from the construction operation shall be repaired to meet or exceed the existing condition at the Contractor's expense.

F. Any losses to the property or any other utility company resulting from the interruption of service from construction or blasting activity, both directly or indirectly, shall be the responsibility of the Contractor, and shall result in no additional cost to the Architect.

G. The Contractor shall make every effort to protect existing utilities including electrical and communications conduits and structures during construction. Any damage to utilities designated to remain shall be repaired immediately at the Contractor's expense.

End of Section

Section 31 23 19

DEWATERING AND DRAINAGE

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. A dewatering plan shall be prepared by a licensed Massachusetts Professional Geotechnical Engineer and submitted for review. Submittal of plan does not constitute approval.

B. The objective of this Section is to remove standing water from excavations as needed to perform the work as specified, and collect water which may enter the excavation during Contractor's excavation activity.

C. Contractor will obtain a NPDES Permit and shall be responsible for collecting and analyzing the requisite water samples to meet the Permit requirements. Contractor is responsible for providing this information to the proper regulatory authorities in a manner consistent with the requirements of the Permit.

D. Contractor shall repair damage caused by dewatering and drainage system operations, at no additional cost to the Owner.

E. Obtain and pay for all permits required for temporary dewatering and drainage system.

F. Furnish, install, operate, monitor, maintain and remove temporary dewatering and drainage systems as necessary to lower and maintain groundwater levels below subgrades of excavations. Prevent surface water runoff from entering or accumulating in excavations.

G. Collect and properly dispose of all water from dewatering and drainage systems in accordance with local, State and Federal requirements and permits.

H. Remove temporary dewatering and drainage systems when no longer needed. Restore all disturbed areas.

1.4 RELATED WORK

A. Earth excavation and backfill are included in Section 31 00 00 – EARTHWORK.

B. Demolition procedures are included in Section 02 41 00 – SITE DEMOLITION.

C. Submittals are included in Section 01 33 00 – SUBMITTAL PROCEDURES.

1.5 SUBMITTALS

A. Shop Drawings for Information in accordance with Section 01 33 00 as part of the Work Plan: For dewatering system. Show arrangement, locations, and details of

wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written report outlining control procedures to be adopted if problems arise with the proposed system.
3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation with geotechnical expertise, retained by the Contractor.
4. Submittal will be for information only. The Contractor shall remain responsible for adequacy, safety, and compliance with appropriate local, state and federal regulations, of construction means, methods and techniques.

1.6 DEFINITIONS

A. Where the phrase “in-the-dry” is used in these specifications, it shall be defined as the in-situ soil moisture content, which will allow the excavated soils to be managed without the generation of free liquids.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the User Agency or others unless permitted in writing by the Architect and then only after arranging to provide temporary utility services according to requirements indicated.

B. Groundwater is anticipated to be encountered throughout construction. Groundwater has been monitored on the following date

PART 2 – PRODUCTS (NOT SPECIFIED)

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall control surface water and groundwater such that excavation to final grade is made in-the-dry, and bearing soils are maintained undisturbed, Contractor shall prevent softening, or instability of, or disturbance to, the subgrade due to water seepage.

B. Contractor shall provide protection against flotation for all work.

C. The impact of anticipated subsurface soil/water conditions shall be considered when selecting methods of excavation and temporary dewatering and drainage systems. Type of dewatering system, spacing of dewatering units and other details of this work shall address site specific conditions.

D. Contractor shall take all necessary measures to prevent damage to adjacent structures, utilities, property(ies), and other features.

E. Contractor shall modify, redesign, and/or replace the dewatering system at no additional cost to the Owner, if design criteria are not continuously and effectively fulfilled.

F. Contractor shall repair damage to adjacent structures, utilities, and properties resulting from the operation of the Contractor's dewatering and treatment system, at no additional cost to the Owner.

G. Contractor shall locate dewatering facilities where they will not interfere with utilities, the safe passage of traveled ways, or other work to be done on the Site under the Specifications.

H. Contractor shall take all necessary precautions during dewatering activities to prevent adverse effects on the Site and on adjacent properties.

3.2 SURFACE WATER CONTROL

A. Contractor shall control surface water runoff to prevent flow into excavations, and shall provide temporary measures such as dikes, ditches and sumps.

3.3 EXCAVATION DEWATERING

A. Contractor shall provide and maintain adequate equipment and facilities to remove promptly and dispose of properly all water entering excavations. Contractor shall keep excavations in-the-dry, so as to maintain an undisturbed sub grade condition throughout construction below grade, including backfill and fill placement.

B. Contractor shall collect precipitation or surface runoff in shallow ditches around the perimeter of the excavation, drain to sump and pump from the excavation to maintain in-the-dry conditions.

C. Dewatering and drainage operations shall at all times be conducted in such a manner as to preserve the natural undisturbed bearing capacity of the sub grade at the bottom of the excavation. If the sub grade becomes disturbed for any reason, the unsuitable sub grade material shall be removed and replaced with concrete, compacted granular fill, or other approved material to restore the bearing capacity of the subgrade to its original undisturbed condition.

D. Dewatering and drainage operations shall be conducted in a manner that does not cause loss of ground or disturbance to the pipe bedding or soil that supports overlying or adjacent structures.

3.4 DISPOSAL OF DRAINAGE

A. All water collected in temporary drainage systems will be collected in the dewatering system and disposed of in the same manner as the dewatered groundwater.

B. The Contractor shall be responsible to ensure that such discharge does not lead to groundwater mounding or other conditions that are not in compliance with the Massachusetts Contingency Plan (310 CMR 40.0000) or the Massachusetts Groundwater Discharge Permit Program 314 CMR 5.00. If discharge is conducted in accordance with a Pretreatment Permit, Contractor is responsible for completing applicable laboratory analysis and maintaining compliance with all permit conditions. Contractor is also responsible for all consequences of non-compliance and/or permit violations. If discharge is completed through off-site disposal, the Contractor is responsible for completing all necessary laboratory analysis to ensure material is within the permit requirements of the accepting facility.

3.5 DISPOSAL OF INCIDENTAL SEDIMENT

A. Other then the collected solids from filtration, any sediment, solids, sludge or soil which accumulates as a result of the dewatering operation, either within the dewatering equipment or external to it, shall be removed from the equipment and the Site and disposed of at no additional cost to the Owner.

End of Section

Section 31 25 00

EROSION CONTROL

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section specifies requirements for control of erosion from the Limits Work onto adjacent down gradient areas as shown on the Drawings, as specified herein for applicable construction activities.

B. Furnish and install hay bales, silt fence, swales, soil berms, mulches, grasses, channels, crushed stone, rip-rap, grading to control runoff, dewatering filter basins, and all other devices required to control erosion. Continually maintain all erosion control devices within the limits of the contract areas. Remove and clean up of all erosion control devices within the limits of the contract areas.

C. RELATED WORK: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 31 00 00, Earthwork for excavation, backfilling and compaction requirements
2. Section 33 40 00, Storm Drainage for installation of Storm Drainage System

1.3 APPLICABLE REGULATIONS

A. In order to prevent erosion and sedimentation from construction activities related to the performance of this project, the Contractor and his subcontractors shall comply with permits issued for the project, all applicable federal, state and local laws and regulations concerning erosion and sediment control, as well as the specific requirements stated in this Section and elsewhere in the Specifications.

1. Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition, herein referred to as the “Standard Specifications” and related articles.
2. Massachusetts “Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers, and Municipal Officials” prepared by Department of Environmental Protection (DEP), Reprinted May 2003.

1.4 QUALITY ASSURANCE

A. The Contractor shall install and maintain sedimentation control devices during construction as specified and as indicated by the SWPPP to prevent the movement of sediment from the construction site to off site areas via surface runoff or underground drainage systems. Measures in addition to those indicated to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.

1.5 DESIGN CRITERIA

A. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.

B. Stabilize disturbed earth surfaces in the shortest practical time and employ any and all such temporary erosion control devices as may be necessary until such time as adequate that soil stabilization has been achieved or permanent erosion control devices are operational.

C. The erosion control devices specified herein represent the minimum required work for erosion control. The Contractor shall add to these minimum devices any and all measures to effectively prevent migration of sediment from the limits of the work area.

D. Within this Section, the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas dated 1997 and the Massachusetts Department of Environmental Protection guidelines shall be the standard source for all erosion and sedimentation control procedures.

1.6 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTALS for submittal provisions and procedures.

B. At least 5 days prior to the start of any other construction, the Contractor will review the installed erosion controls with the Architect.

C. At least 5 days prior to intended use, the Contractor shall provide the following samples and/or submittals for approval. Do not order materials until the Architect's approval of samples, certifications or test results has been obtained. Delivered materials shall closely match the approved samples.

1. Silt Fence: Submit manufacturer's material specification and installation instructions.
2. Inlet Protection.
3. Mulch Material: Submit one Cubic Foot Sample.
4. Mesh of Matting: Submit One square foot sample and manufacturer's technical description and installation instructions.

D. Implementation Plan

Prior to commencement of the work, the Contractor shall:

1. Meet with the Architect to develop mutual understandings relative to compliance with the provisions of this Section.
2. Install all erosion control measures as specified on the Drawings.
3. Should the Contractor desire to change or modify the specified erosion controls then he shall submit in writing his plans to the Architect for implementing erosion and sediment control including, but not limited to, placement of hay bales, silt fence, containment berms, temporary channels, settling ponds, and dewatering filter basins, as well as a description of all construction techniques intended to minimize erosion and sedimentation, and a program for maintenance of these facilities throughout the performance of construction activities.
4. The Contractor shall submit design and sizes of all dewatering filter basins.

PART 2 – MATERIALS

2.1 HAY BALES

A. Bales shall be made of straw or hay with forty pounds minimum weight and one hundred and twenty pounds maximum weight. They should be either wire or nylon bound. Wood stakes shall be a minimum of 2 inch by 2-inch nominal size by a minimum of 3 feet long. As an alternate, No. 4 size steel reinforcing bars may be used with rubber safety tops.

2.2 SILT FENCE

A. Silt fences or sedimentation barriers shall consist of wood posts with industrial support netting and sediment control filter fabric attached.

B. Wood post shall be standard 2”x2”x4.5’ long hardwood stakes commonly used to support filter fabric. Silt fence shall be furnished standard with filter fabric attached to hardwood posts and spaced at a maximum distance of 8 feet.

C. Provide suitable heavy nylon cord for securing abutting silt fence posts.

D. The filter fabric material shall be needle punched non-woven polypropylene geotextile conforming to the following criteria:

Minimum Acceptance

Fabric Properties	Value	Test Method
Grab Tensile Strength (lbs)	124	ASTM D4632
Elongation of Failure (%)	15	ASTM D4632
Mullen Burst Strength (PSI)	300	ASTM D3786
Puncture Strength (lbs)	100	ASTM D4833
Flow Rate (gal/min/sf)	10	ASTM D4491
Apparent Opening Size (sieve)	30	ASTM D4751
Ultraviolet Radiation (% strength retained)	70	ASTM D4355
Trapezoidal Tear Strength (lbs)	60	ASTM D4533
Permittivity (sec^{-1})	.01	ASTM D4491

E. Control fabric shall be at least 3 feet wide.

2.3 CATCH BASIN INSERTS

A. Siltsack®, Basin bag, Ultra-BasinGuard or equal shall be manufactured from a specially designed woven polypropylene geotextile. The insert will be manufactured to fit the opening of the catch basin or drop inlet.

2.4 FILTER SOCKS

A. Filter Socks are biodegradable sediment-trapping devices. Manufacturers include SiltSoxx, Corr Logs, Straw Wattles, or equivalent.

2.5 STONE STABILIZATION PAD

A. Material as shown on Drawings to ensure no offsite tracking of soil.

2.6 WATER

A. Water used for dust control and equipment washes shall be clean and free of salt, oil, and other injurious materials. Water is not available on site. The Contractor shall provide all necessary water.

PART 3 – EXECUTION

3.1 GENERAL EROSION CONTROL REQUIREMENTS

A. All materials and installation shall be in accordance with the Drawings.

B. Means of protection as noted on the Drawings indicate the minimum provisions necessary. Additional means of protection shall be provided by the Contractor as needed for continued or unforeseen erosion problems, at no additional expense to the Owner.

C. The Architect has the authority to control the surface area exposed by construction operations and to direct the Contractor to immediately provide permanent or temporary erosion control measures to prevent contamination of adjacent streams, watercourses, lakes, ponds or other areas of water impoundment. Every effort shall be made by the Contractor to prevent erosion on the site and abutting property.

D. All slopes shall be stabilized by mulching, seeding or otherwise protected as the work progresses to comply with the intent of this specification. All damaged slopes shall be repaired as soon as possible. The Architect shall limit the surface area of earth material exposed if the Contractor fails to sufficiently protect the slopes to prevent pollution.

E. The Contractor shall at all times have on hand the necessary materials and equipment to provide for early slope stabilization and corrective measures to damaged slopes.

F. The Contractor shall continually maintain all erosion control devices within the contract work limit and shall remove such devices upon completion of the Work and surface stabilization, or if ordered by the Architect.

G. The Contractor shall operate all equipment and perform all construction operations

so as to minimize pollution. The Contractor shall cease any of his operations, which will increase pollution during rainstorms.

H. The Contractor shall place additional erosion and sedimentation controls in accordance with by laws and regulations.

I. After any significant rainfall (more than 1 inch of rainfall in a 24 hour period), sediment control structure shall be inspected for integrity. Any damaged devices shall be corrected immediately.

3.2 HAY BALE INSTALLATION

A. Bales shall be set lengthwise on the contour for sheet flow applications. They shall be held in place by two wooden stakes in each bale as detailed on the Drawings. Bales shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Architect.

B. Bales shall be set with bindings parallel to grade and entrenched to a minimum depth of 6 inches. Stakes shall be driven a minimum of 18 inches into the ground and cut off flush with the top of the bale.

C. After the bale lines are staked, the end joints shall be chinked with loose straw to close any gaps. Excavated soil shall then be backfilled against the uphill side of the barrier to a depth of 4 inches above the downhill grade.

D. Inspection shall be weekly and repair or replacement shall be made as needed.

E. Following compaction of the backfill, loose straw shall be scattered over the surface directly behind the barrier.

F. Hay bale checks should be placed in diversions generally at 50-foot intervals and in accordance with the detail on the Drawings. Sediment shall be removed from behind the checks when it has accumulated to one-half the original height of the dam measured at the low point.

3.3 SILT FENCE INSTALLATION

A. Silt fence shall be installed utilizing posts 4.5 feet long minimum staked at least 8’ on center. Prior to installation, a 6-inch by 8-inch deep anchor trench shall be installed at the base of the fence and the final height will be at minimum 2 feet.

B. Inspect siltation fence periodically and remove accumulated sediment.

3.4 DIVERSIONS

A. Diversions for directing surface runoff away from and/or around trenching and other construction operations shall be installed and stabilized in advance of new work. The Contractor shall select the cross-Sectional shape (parabolic, v-shaped or trapezoidal) of diversions and shall have proper equipment available on-site for maintenance of the diversions.

B. The minimum capacity of the diversion shall be sized to accommodate a 2-year design storm.

C. Periodic cleaning shall be done to maintain capacity.

3.5 DEWATERING DISCHARGES

A. All pumped discharges and surface water flow from work areas shall be passed through a filter barrier of hay bales and silt fence combination or dewatering bags before being discharged into gutters, ditches, drainage swales, storm sewer systems, wetlands, natural water bodies, streams, or rivers. The method of all such discharges shall be subject to the approval of the Architect.

B. The Contractor shall design and size all dewatering discharge basins such that the discharge from the basins is free of silt and debris to the satisfaction of the Architect and all applicable regulatory agencies.

3.6 CATCH BASIN INSERTS

A. Installation of inserts shall be prior to any upstream soil disturbance.

B. Inserts shall be inspected after each rain event and at a minimum every two weeks.

C. Debris and silt shall be cleaned on a regular basis.

3.7 REMOVAL AND CLEAN-UP

A. All temporary erosion control facilities and accumulated sediments shall be removed and legally disposed in a neat and workmanlike manner when all disturbed areas have been satisfactorily stabilized.

End of Section

Section 32 00 00

BITUMINOUS CONCRETE PAVEMENT, CURBING AND EDGING

PART 1 – GENERAL

1.1 Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 WORK TO BE PERFORMED

A. Work under this section includes installation of bituminous concrete pavements, curbing and pavement markings for roadways and parking areas as shown on the Drawings. All existing pavement to remain, but damaged, as a result of the construction operations, shall be restored in accordance with the requirements of this Section. Trench fills for trench excavations through roadways shall consist of general pavement structures according to this Section.

B. The Contractor shall install all pavement and drives, which have been removed or damaged during construction operations. Pavement shall include satisfactory repair by the Contractor of driveways and any other surface disturbed by his/her operations by the same materials as removed or as specified herein. Driveway aprons shall be part of the work.

C. Items to be Installed:

1. Concrete Curbing
2. Granite Curbing
3. Pavement Markings
4. Bituminous concrete curbs
5. Paving

D. Related Work:

1. Section 31 00 00 – EARTHWORK
2. Section 31 23 19 – DEWATERING AND DRAINAGE
3. Section 32 17 23 – PAVEMENT MARKINGS
4. Section 03 30 00 – CAST-IN-PLACE CONCRETE

1.3 REFERENCES

A. All work specified in this Section shall conform to the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges latest revision, herein referred to as "State Standards".

B. All work specified in this Section shall conform to the Rules and Regulations governing the Subdivision of Land in the City of Beverly, Massachusetts.

C. American Society of Testing and Materials (ASTM) (latest edition):

1. C 33 Specification for Concrete Aggregates.
2. C 136 Method for Sieve Analysis for Fine and Coarse Aggregate.

3. C 140 Sampling and Testing Concrete Masonry Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. C 936 Specifications for Solid Interlocking Concrete Paving Units.
6. C 979 Specification for Pigments for Integrally Colored Concrete.
7. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
8. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
9. D 2940 Graded Aggregate Material for Bases and Subbases for Highways or Airports.
10. C 29 Bulk Density and Voids in Aggregate Materials.

1.4 PRODUCT HANDLING

A. Use all means necessary to protect bituminous concrete pavement materials before, ongoing, and after installation, and to protect the installed work and materials of all other trades.

B. In the event of damage, immediately make all repairs and replacements necessary as directed by the Architect.

1.5 SUBMITTALS

A. The Contractor shall submit to the Architect, data showing gradation and composition of materials proposed.

B. The bituminous concrete mix formula must be submitted to the Architect prior to the initiation of paving operations.

1.6 QUALITY CONTROL

A. For actual finishing of bituminous concrete surfaces and operation of the required equipment, use only personnel who are thoroughly trained and experienced in the skills required and whose prime occupation is this type of work.

B. Existing paved areas damaged or removed shall be repaired or replaced, respectively, with the same materials and level of quality as on the Project.

1.7 GUARANTEE/WARRANTY

A. Material Guaranty: Before any contract is awarded, the Bidder may be required to furnish without expense to the Architect complete statement of the origin, composition and manufacture of any or all materials proposed to be used in the construction of the work, together with samples, which may be subjected to the tests required by the Architect to determine the quality and fitness of the material.

PART 2 – MATERIALS

2.1 MATERIALS

A. Subgrade base course material shall conform to the applicable subsections of Section 310000, Earthwork of this Specification.

B. Bituminous Concrete Pavement shall conform to the applicable subsections of Section 460, Class I Bituminous Concrete Pavement, Type 1 of the "Standard Specifications."

2.2 PAVEMENT BASE

A. Conform to Sand Gravel Fill as specified in Section 31 00 00, EARTHWORK.

2.3 PAVEMENT SUB BASE

A. Conform to granular fill as specified in Section 31 00 00, EARTHWORK.

2.4 SUBGRADE

A. Reuse on-site material or imported material as specified in Section 31 00 00, EARTHWORK.

2.5 CONCRETE CURBING

A. All curbing shall placed so that areas behind curbs shall be graded smooth, and topsoil and seed shall be placed.

B. Concrete curbs shall be in accordance to MHD Standard Specifications M9.04.1 and installed in accordance to MHD Std. Spec. Section 500.

2.6 GRANITE CURBING

A. All curbing shall be placed so that areas behind curbs shall be graded smooth, and topsoil and seed shall be placed.

B. Granite curbs shall be in accordance to MHD Standard Specifications M9.04.1 and installed in accordance to MHD Std. Spec. Section 500.

2.7 BITUMINOUS BERM / CURB

A. Bituminous berm shall be Class I Bituminous Concrete, Type I-1 in accordance with MHD Standard Specifications Section 470.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor Requirements:

1. The Contractor shall perform and complete the Work within the limits indicated in a continuous manner so that the pavement placement work may proceed without delay.
2. The Contractor shall, at all times, prior to acceptance of the work by the Architect, maintain the completed work in a safe and satisfactory condition. All maintenance and repairs to the completed work shall be subject to the approval of the Architect and the controlling municipal and State authorities. All maintenance and repairs of the completed work shall be provided by the Contractor at no additional cost to the Architect.
3. Equipment used in the work will be subject to approval by the Architect and shall be maintained in a satisfactory condition at all times. Unless otherwise

permitted, compaction shall be performed by use of suitable power rollers. Finished surfaces of new asphaltic surface courses shall finish even with adjacent existing pavement surfaces and be free from surface irregularities.

4. It shall be the responsibility of the Contractor to obtain from the controlling municipal authorities all required permits for cutting roadway pavements and to perform the work in accordance with all customs and requirements of the controlling authorities, in addition to those specified herein, and at no additional expense to the Architect.
5. Existing pavements outside of the indicated work limits which are damaged as a result of the Contractor's operations, including base courses, bituminous tack coats and surface courses, shall be replaced by the Contractor in accordance with the requirements specified herein for the respective type of pavement; in a satisfactory manner and at no additional cost to the Architect.
6. In case of settlement or other defects in new or replaced pavements, the Contractor shall cut out, replace, restore or repair the damaged pavements at no additional expense to the Architect. This requirement shall remain in effect for 2 years after the acceptance of the work by the Architect. The pavement area to be replaced, repaired or restored, shall extend from edge of pavement to edge of pavement, a minimum of 20 feet on either side of the defect; final pavement course shall be feathered to provide a smooth finish detail.
7. This Contract shall not be considered complete until the replacement, restoration and repair of pavements has been provided in a manner satisfactory to the Architect, and in accordance with the requirements specified herein.

B. All materials and each part of detail of the work shall be subject to inspection by The Architect. The Architect shall be allowed access to all parts of the Work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect.)

C. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the Work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor’s expense.

D. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor’s expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks in advance of the incorporation in the work of any such materials.

E. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted

access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

F. The inspection of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract a herein prescribed by the plans and specifications.

G. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor obligate the Architect to make final acceptance.

H. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

3.2 SUBGRADE PREPARATION

A. Prepare subgrade by shaping and compacting to proper grade. Remove all soft and yielding material from the subgrade and replace with suitable material. Compact thoroughly using approved types of rollers or tampers. Insure that all areas are stable and dry.

B. Saw cut edges of existing pavement along even lines to obtain undisturbed, clean and sound vertical edges of original pavement.

C. Do not store or stockpile materials on the subgrade.

3.3 PAVEMENT

A. The subbase to be placed under pavement shall consist of at least 12 inches of base course as specified in Section 31 00 00, Earthwork, evenly spread and thoroughly compacted.

1. Compaction of the subbase shall be in accordance with Section 31 00 00 Earthwork
2. All thicknesses are measured after rolling. The permanent surface course shall be evenly spread and rolled with a power roller having a minimum weight of 5 tons.

3.4 COMPACTION

A. The Contractor shall conform to the State Standards for pavement operations, including compaction (401.03.10).

B. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture is in the proper condition and when rolling does not cause undue displacement, cracking and shoving.

C. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Rolling shall be continued until all roller marks are eliminated and the minimum densities have been obtained based upon 95 percent of laboratory Marshall Densities made in the proportions of the job-mix formula, AASHTO T-245.

D. Steel-Tired, Static Weight Rollers: The maximum roller speeds for steel-tired static-weight rollers for various operations shall not exceed three miles per hour. The wheels of steel-wheel rollers shall be kept moist and clean to prevent adhesion of the fresh material, but an excess of water will not be permitted.

E. Vibratory Rollers: The maximum roller speed for vibratory rollers shall be that which provides impact spacing less than the compacted lift thickness. When vibratory rollers are used in the static mode, roller speed shall not exceed three miles per hour.

1. When an approved vibratory roller is used for breakdown rolling in a vibratory mode, intermediate rolling will not be required. When the vibratory roller is used for finish rolling it shall be used in the static mode. Rolling shall progress continuously until the specified density of the corresponding daily plant Marshall Density, AASHTO T-245 has been attained. Finish rolling shall continue until all roller marks are eliminated.

F. Unless otherwise directed, rolling shall start longitudinally at the sides and gradually progress toward the center of the pavement.

G. The motion of the rollers shall be slow enough at all times to avoid displacement of the hot mixture. Any displacement resulting from reversing the direction of the rollers or from any other cause shall be satisfactorily corrected.

H. When the base course or binder course fails to comply with the density requirements herein specified, additional compaction may be applied when permitted and as directed, to attain the required density. If satisfactory density cannot be attained the Contractor shall be required to remove and replace, at his own expense, any affected area, which is proven to be structurally inadequate and/or incapable of maintaining material integrity.

I. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with fresh hot mixture, which shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

J. In the event of dispute as to the creditability of the results, density shall be determined from cores taken from the pavement.

3.5 FIELD QUALITY CONTROL

A. Thickness: Test in-place asphalt concrete courses for compliance with requirements for thickness. Repair or remove and replace unacceptable paving as directed by the Architect. In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness.

B. Compaction:

1. The Bituminous mixture shall be compacted to at least 95% of the density achieved on the laboratory testing of the design mix for the project.
2. Density will be checked by the Nuclear Density gage Method, ASTM 2950.

C. Guarantee: During the two-year guarantee period, the Contractor shall maintain the surfacing and shall promptly fill with similar material in compliance with the

above specifications, any depressions and hold that may occur so as to keep the surfacing in a safe and satisfactory condition for traffic.

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Section 32 13 13
SITE CONCRETE

PART 3 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work included: Provide all labor, materials, equipment, and transportation necessary to complete the placement of concrete. Such work includes, but is not limited to, the following:

1. Furnishing, placing, curing, finishing and protection of all plain and reinforced concrete work, above and below grade of the Site. Also, include all concrete work necessary to complete the work of other trades.
2. Coordination with all other trades for location of all pipe sleeves, duct openings, electrical boxes and conduits and other devices required by other trades.
3. Prepare program of inspections of all concrete work and perform such tests and inspections.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 31 00 00, Earthwork for excavation, backfill and compaction requirements.
2. Section 32 00 00, Paving Walkways, Curbing, and Edging for installation of curbing.

3.3 SUBMITTALS

A. Refer to Section 01 33 00 Submittals provisions and procedures.

1. Material Certificates: Provide copies of material certificates signed by material producer and Contractor certifying that each material item complies with, or exceeds, specified requirements.
2. Plant mix design for concrete.
3. Submit manufacturer’s literature describing products, installation procedures and routine maintenance.
4. Samples for Verification Purposes: Submit three (3) samples of surface applied polyurethane tactile mat of the kind proposed for use.
5. Shop drawings are required for products specified showing fabrication details; tile surface profile; adhesives; plans of mat placement including joints, and material to be used as well as outlining installation materials and procedure.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the Work of this Section to the extent referenced herein:

1. Commonwealth of Massachusetts, Massachusetts Highway Department (MHD), Standard Specifications for Highways and bridges, latest English Edition with amendments, hereinafter referred to as the "Standard Specifications." All referenced to method of measurement, basis of payment and payment items in the Standard Specifications are herby deleted. References made to particular Sections or paragraphs in the Standard Specifications shall include all related articles mentioned therein.
2. Commonwealth of Massachusetts, Massachusetts Highway Department, Construction Standards, latest Edition with amendments hereinafter referred to as the "Construction Standards."
3. ASTM: American Society for Testing and Material.
4. AASHTO: American Association of State Highway and Transportation Officials.
5. ACI: American Concrete Institute.
6. All ramps and curb ramps shall comply with American Disabilities Act Accessibility Guidelines and the Massachusetts Architectural Access Board (MAAB).

1.5 TESTING, CONTROL AND INSPECTION

A. The Contractor will retain the services of a qualified independent testing agency, approved by the Architect, to test aggregate and to prepare a mix design for each strength of concrete specified; and shall submit such mix designs and test results to the Architect for approval. Mix designs may also be based on proven current designs accompanied by test results. The costs of all such preliminary services shall be borne by the Contractor.

B. The Owner will retain the services of a concrete testing company to provide concrete sampling and testing.

1. Testing equipment will be provided by and tests performed by the testing laboratory. Upon request by the Architect, the testing laboratory shall provide such auxiliary personnel and services needed to accomplish the testing work.
2. Concrete test cylinder tests shall be taken for each 50 cubic yards of concrete placed, but at least one set for each day of concrete placements.
3. Testing required because of changes requested by the Contractor in materials, sources of materials or mix proportions, and extra testing of concrete or materials because of failure to meet the Specification requirements shall be paid by the Contractor.
4. Concrete shall be sampled and tested for quality control as follows:
    a. Sampling fresh concrete: ASTM C172
    b. Concrete test specimens: ASTM C31
    c. Slump: ASTM C143. – Slump shall be one to three inches, or five to seven inches with Super plasticizer.
    d. Air Content: ASTM C231 – Air content shall be 6% +/- 1%.

e. Compressive strength: ASTM C39 – Concrete shall be 4000 psi at 28 days

f. Unit Weight: ASTM C29

1.6 NOTIFICATION OF RELATED TRADES

A. Notify all other trades responsible for installing chases, electrical handholes, conduit, and other electrical utilities when ready for such installation, and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.

PART 4 - PRODUCTS

4.2 BOLLARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable.

B. Bollard Construction:

1. Bollard shall be constructed of 6" ID Schedule 40 steel pipe and filled with 3,000 PSI concrete.
2. Bollard shall be capped with 1/4" steel plate welded to pipe and shall be grinded smoth.

C. Steel Finish: Color Coated.

1. Color: As indicated by Concrete Bollard detail on sheet C6.2, Site Details No. 2.

4.3 CONCRETE

A. Portland Cement: ASTM C-150 Type 1: All cement shall be from a single source.

B. Natural Aggregates:

1. Fine Aggregate for Concrete: Shall be natural sand consisting of clean, hard, durable, uncoated particles, conforming to ASTM C33. Organic content shall be determined according to ASTM C40. Allow no frozen or partially frozen aggregate in the mix.
2. Course Aggregate for Concrete: For regular weight concrete use crushed stone or gravel from approved source conforming to ASTM C33. Coarse aggregate shall not contain greater amounts of deleterious material than specified in table III, ASTM C33.

C. Water from approved source, potable, clean and free of oils, salt, alkali, organic matter and other deleterious material.

2.2 DETECTABLE WARNING SYSTEM

A. Description

1. This Section includes Specifications for furnishing and installing Cast In Place Replaceable Detectable Warning Surface Tiles (REP) with an in-line truncated dome pattern, embedded in all curb ramps and walking surfaces at the locations and to the dimensions shown on the Drawings, in accordance with the Contract Documents and as directed by the Engineer.

B. Quality Assurance
   1. Provide composite cast-in-place replaceable detectable warning surface tiles as produced by a single manufacturer with a minimum of five years' experience in manufacturing cast in place replaceable detectable warning surface tiles.
   2. Installer's Qualifications: Engage an experienced installer certified in writing by the Detectable Warning Surface manufacturer, who has successfully completed Detectable Warning Surface installations similar in material, design, and extent to that indicated for the Contract.
   3. Cast in place replaceable detectable warning surface tiles shall meet or exceed the following test criteria using the most current test methods:
      a. Compressive Strength: 28,900 psi minimum, when tested in accordance with ASTM D695.
      b. Flexural Strength: 29,300 psi minimum, when tested in accordance with ASTM D790.
      c. Water Absorption: Not to exceed 0.10%, when tested in accordance with ASTMD570.
      d. Slip Resistance: 1.05 minimum wet and 1.18 dry static coefficient of friction when tested in accordance with ASTM C1028.
      e. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.
      f. Salt and Spray Performance of Detectable Warning Surface: No deterioration or other defects after 200 hours of exposure, when tested in accordance with ASTM-B117.
      g. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D543.
      h. Abrasion Resistance: 500 minimum, when tested in accordance with ASTM C501.
      i. Accelerated Weathering of Detectable Warning Surface when tested by ASTM-G155 or ASTM G151 shall exhibit the following result: $\Delta E<5.0$ at 2,000 hours minimum exposure.
      j. Tensile Strength: 11,000 psi minimum, when tested in accordance with ASTM D638.
      k. AASHTO-H20 Load Bearing Test: No Damage at 16,000# loading.
      l. Freeze/Thaw/Heat: No deterioration when tested in accordance with ASTM C 1026.

C. Delivery, Storage, and Handling
   1. Cast in place replaceable detectable warning surface tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.
   2. Storage Facility:
      a. Store tiles in an area that is within an acceptable temperature range (40-90 degrees). In particular, protect sealants from freezing.
      b. Maintain Storage Facility in a clean dry condition to prevent contamination or damage to tiles and incidentals.
      c. Contractor shall provide six (6) replacement detectable warning surface tiles to the Owner as attic stock at the completion of the project.

D. Guarantee
   1. Cast in place replaceable detectable warning surface tiles shall be guaranteed in writing for a period of five (5) years from date of Contract's final com-

pletion. The guarantee includes manufacturing defects, breakage, and deformation.

E. Materials
1. Cast in place replaceable detectable warning surface tiles shall be manufactured using a matte finish exterior grade homogeneous glass and carbon reinforced polyester based Sheet Molding Compound (SMC) composite material. Truncated domes must contain fiberglass reinforcement within the truncated dome for superior structural integrity and impact resistance. A matte finish will be required on the Detectable Warning Surface for superior slip resistance performance superior to that offered by a gloss finish.

F. Colors
1. Cast in place replaceable detectable warning surface tiles shall contrast visually with adjacent walking surfaces either light-on-dark, or dark-on-light. Coordinate color selection with Owner prior to furnishing and installing tiles.

2.3 CONCRETE ADA ACCESSIBLE CURB CUTS

A. Contractor shall install concrete ADA accessible curb cuts at all locations shown on plans. Curb cut configurations shall be as detailed on the Drawings.
1. All concrete curb cuts shall be isolated from surrounding concrete pavement when applicable.
2. Curb cuts shall be built with cut curbstone to match concrete curb cut slopes.

B. Curb cuts shall comply with all requirements established by the Architectural Access Board, Commonwealth of Massachusetts, CMR 521.

C. Curb cuts shall not exceed:
1. Cross-slopes at front and back of curb cuts: 1.5% max.
2. Curb cuts: 7.5% max

D. All planes of the finished curb cuts shall be field checked for slopes using a two-foot electronic “smart” level.
1. Curb cuts that do not comply with the slope requirements shall be cut out in their entirety and completely rebuilt.

2.4 CONCRETE RAMPS

A. All ramps to comply with ADA Accessibility Guidelines and MAAB.

B. All ramps shall be sloped no greater than 1:12.

C. Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:
1. The landing shall be at least as wide as the ramp run leading to it.
2. The landing length shall be a minimum of 60 in (1525 mm) clear.
3. If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

2.5 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.6 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A 82/A 82M

I. Deformed-Steel Wire: ASTM A 496/A 496M.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from

steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

P. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

Q. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

R. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

S. Zinc Repair Material: ASTM A 780.

PART 3 - EXECUTION

3.1 CONCRETE BOLLARDS

A. EXAMINATION

1. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION, GENERAL

1. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
2. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
3. Install site furnishings level, plumb, true, and [**securely anchored**] [**positioned**] at locations indicated on Drawings.
4. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
5. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
6. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.2 MIXING PROCESS FOR CAST-IN-PLACE CONCRETE

A. Ready-mixed concrete shall be mixed and transported in accordance with specification for Ready-Mixed Concrete" ASTM C94, Alt. No. 3 and ACI Standard 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. The concrete shall be of such consistency and be so spaced and worked that a smooth mortar face will be replaced.

3.3 EMBEDDED ITEMS FOR CAST-IN-PLACE CONCRETE

A. Coordinate the installation of all inserts required by other trades.

3.4 PLACING OF CAST-IN-PLACE CONCRETE

A. Notify the Architect at least 48 hours prior to each placement.

B. Do not place concrete until conduit, catch basin frame and grates, manhole frames and covers, granite curing and other work to receive the concrete have been inspected and approved by the Architect and all other trades concerned.

C. In hot weather all concreting shall be done in accordance with ACI 306, "Recommended Practice for Hot Weather Concreting".

D. In cold weather, all concreting shall be done in accordance with ACI 306, "Recommended Practice for Cold Weather Concreting".

E. Conveying: Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods that will prevent separation or loss of ingredients and in a manner which will assure that the required quality of the concrete is retained.

F. Depositing: Delivery and placement of concrete shall be programmed so that the time lapse between batching and placement shall not exceed 1-1/2 hours. Concrete shall not be allowed a free fall over 4 feet. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing.

G. Concrete shall be deposited continuously, in horizontal layers of such thickness (not deeper than 18 inches) that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the Section. Placing shall be carried out at such a rate that the concrete, which is being integrated, with fresh concrete is still plastic. Concrete which ash partially hardened or which ash been contaminated with foreign materials shall not be deposited.

3.5 INSTALLATION OF DETECTABLE WARNING SYSTEM

A. During all concrete pouring and REP Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards..

B. The physical characteristics of the concrete shall be consistent with the Contract Specifications while maintaining a slump range of 4 - 7 to permit solid placement of the REP Tile. An overly wet mix will cause the REP Tile to float. Under these

conditions suitable weights such as 2 concrete blocks or sandbags (25 pounds) shall be placed on each REP Tile.

C. The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to REP Tile placement.

D. To the maximum extent possible, the REP Tiles shall be oriented such that the rows of in-line truncated domes are parallel with the direction of the ramp. When multiple REP Tiles regardless of size are used, the truncated domes shall be aligned between the detectable warning surface tiles and throughout the entire detectable warning surface installation.

E. The REP Tiles shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the detectable warning surface tile is flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

F. On Continuous Runs: The Installer shall leave a 1/8” nominal gap between successive Detectable Warning Surface Tiles. As part of the concrete finishing operation, the Installer shall apply ¼” edge treatment around the perimeter of the detectable warning surface tiles to facilitate future replacement of the detectable warning surface tile. A urethane sealant such as Sikaflex 1a or BASF NP1 shall be applied to the edge treatment for a watertight detectable warning surface tile installation.

G. During and after the REP Tile installation and the concrete curing stage, it is imperative that there are no walking, leaning or external forces placed on the REP Tile to rock the REP Tile, causing a void between the underside of the REP Tile and the concrete substrate.

H. Remove protective plastic sheeting from REP Tile within 24 hours of installation of the REP Tile. articularly under hot weather conditions (80 degrees or higher), plastic sheeting will adhere strongly (resulting in difficult removal of same) to detectable warning surface tile when not removed quickly.

I. Clean REP Tiles by method specified by the manufacturer.

3.6 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.7 STEEL REINCORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

End of Section

Section 32 14 00
UNIT PAVERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Unit Paver Type A – at crosswalks
   2. Unit Paver Type B – at outdoor learning bus drop-off
   3. Unit Paver Type C - at outdoor learning and entrance

1.2 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:
   1. Section 03 30 00 - Cast-in-Place Concrete
   2. Section 31 00 00 - Earthwork
   3. Section 32 00 00 - Bituminous Concrete Paving
   4. Section 32 13 13 – Site Concrete
   5. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
   6. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
   7. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 SUBMITTALS

A. Product Data: For materials other than water and aggregates.
   1. All Unit Paver Types shall be submitted to the Landscape Architect.

B. Sieve Analyses: For aggregate, washed sand and setting-bed materials, according to ASTM C 136.

C. Samples for Initial Selection: For the following:
   1. Each type of unit paver indicated.
   2. Polymeric joint sand

D. Samples for Verification:
   1. Three (3) Full-size paver units of each type of unit paver indicated, in the color to be installed.
   2. Joint materials for sidewalks and crosswalks.

3. Compatibility and Adhesion Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

E. Provide all qualification data listed in Section 1.4 of this specification.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be non staining to, installed pavers and other materials constituting paver installation.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion. Mockups shall be at least 6'x6' square.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 – PRODUCTS

2.1 Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and

such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

2.2 UNIT PAVER TYPE A – AT CROSSWALKS

A. Unit Paver Type A shall be a granite cobble paver. Color shall be a salt and pepper medium grain gray similar to Stanstead or Woodbury, or approved equivalent. Size of granite cobbles shall be approximately 4”x4”x8”. Source of stone can be from salvage facility or quarry that can provide the job quantity.

2.3 UNIT PAVER TYPE B – AT OUTDOOR LEARNING BUS DROP-OFF

A. Unit Paver Type B shall be an 8”x8” concrete unit paver with an exposed grant finish. Pavers shall conform to ASTM C936, Standard Specification for Interlocking Concrete Paving Units. The average comprehensive strength shall be a minimum of 8000 psi and an average water absorption of no more than 5% when tested according to ASTM C140. The radius of rupture shall not be less than 1,000 pounds per square inch. Resistance to 50 freeze thaw cycles, when tested according to ASTM C1645, with breakage greater than 1.0% loss in dry weight of any individual unit. Color shall be a 1/3 Black Granite and 2/3 Peppered Granite. **Contractor shall refer to the plans for details of base.**

B. Acceptable Manufacturers for brick pavers include the following:

1. Unilock- Model# Series 3000
2. Belgard – Model# Urbana Stone
3. Ideal Concrete Block – Model# Fineline Series
4. Or equivalent.

2.4 UNIT PAVER TYPE C – AT OUTDOOR LEARNING AREA AND ENTRANCE

A. Unit Paver Type C shall be an 4”x16”x4” or 4”x18”x3” concrete unit paver with an exposed grant finish. Pavers shall conform to ASTM C936, Standard Specification for Interlocking Concrete Paving Units. The average comprehensive strength shall be a minimum of 8000 psi and an average water absorption of no more than 5% when tested according to ASTM C140. The radius of rupture shall not be less than 1,000 pounds per square inch. Resistance to 50 freeze thaw cycles, when tested according to ASTM C1645, with breakage greater than 1.0% loss in dry weight of any individual unit. Color shall be a 1/3 Black Granite and 2/3 Peppered Granite. **Contractor shall refer to the plans for details of base.**

B. Acceptable Manufacturers for brick pavers include the following:

1. Unilock – Model# Promenade Paver
2. Belgard – Model# Moduline Series Plank
3. Interlock – Model# Broadmour Plank
4. Or equivalent.

2.4 SETTING-BED MATERIALS

A. Sand Gravel Base: Shall comply with requirements in Section 31 00 00 – Earthwork.

B. Concrete Base: Shall comply with 32 13 13 – Site Concrete

C. Sand for Leveling Course: Sound, sharp, washed, natural sand complying with gradation requirements in ASTM C 33 for fine aggregate.

D. Filter Fabric: Shall comply with requirements in Section 31 00 00 – Earthwork for Geotextile Fabric.

E. Sand for Paver Joints: Polymeric Sand, manufactured sand with polymer binders and calibrated aggregate size with 100 percent passing No. 16 sieve.

1. Color: to match adjacent paving.

F. Peastone: Shall comply with requirements in Section 31 00 00 – Earthwork for Peastone.

2.5 FLATNESS TOLERANCES

A. A 4-foot dimension in any direction on the surface shall determine variation from true plane, or flat surfaces. The maximum variation from true plane shall not exceed 1/8 inch per 12 inches or 1/8 of the specified joint width, whichever is greater.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

2 Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Remove substances from base surface and/or concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

3.3 INSTALLATION GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, un-chipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Exercise care in handling coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. Remove coating from bonding surfaces before setting brick.

E. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Expansion and Control Joints: Where applicable provide for sealant-filled joints at locations and of widths indicated. Provide foam filler as backing for sealant-filled joints, if indicated. Color of sealant shall match adjacent pavers.

3.4 SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill.

C. Place pavers on sand leveling course, laid over fully cured concrete base, compact by tamping with plate vibrator, and screed to depth indicated.

D. Where applicable core drill 2” holes in concrete rigid base for drainage as indicated in plans.

E. Place drainage geotextile over drill holes after filling with crushed peastone.

F. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care of that moisture content remains constant and density is loose and constant until pavers are set and compacted.

G. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

H. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover pavers that have not been

compacted, and leveling course on which pavers have not been placed, with non-staining plastic sheets to protect them from rain.

I. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

J. Do not allow traffic on installed pavers until sand has been vibrated into joints.

K. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: When applicable, when tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess sand or grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION

Section 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within SECTION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section shall include: Labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The work covered under this Section of the Specifications includes furnishing all labor, equipment, appliances and materials, and performing all operations in connection with the furnishing and placing of the pavement marking as indicated on the Drawings and as herein specified.

B. Related Sections include the following:

1. Section 31 00 00 "Earthwork" for soil materials, excavating, backfilling, and site grading.
2. Section 32 00 00 Bituminous Concrete Pavement, Curbing and Edging for placement of vertical granite curbing and paving of roadways and walkways.

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified pavement marking installer whose work has resulted in successful establishment pavement markings.

1. Installer's Field Supervisions: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress.

1.5 REFERENCE STANDARDS

A. All work shall conform to the Commonwealth of Massachusetts, Massachusetts Highway Department, Standard Specifications for Highways and Bridges, hereinafter referred to as the Standard Specification, section 840 and 860, and Engineering Directive Dated June 16, 2005.

1.6 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage to existing signs prior or during removal and resetting.

PART 2 - MATERIALS

2.1 Final Pavement Markings within MassDOT Right-of-way shall be thermoplastic, conforming to Massachusetts Standard Specifications.

2.2 Final Pavement Markings onsite shall be epoxy resin, conforming to Beverly and Massachusetts Standard Specifications.

2.3 Pavement markings shall be “white” or “yellow” in color, unless otherwise noted on Drawings.

2.4 General pavement marking delineation for parking stalls shall measure 4 inches in width. All other pavement-marking widths are shown in detail on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of pavement markings shall be in accordance with the Massachusetts Standard Specifications and Manufacturer’s Requirements.

B. Pavement marking should be installed within 48 hours after the final pavement installation.

3.2 INSPECTION

A. All materials and each part or detail of the work shall be subject to observation by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect).

B. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor’s expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of the materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks (or as otherwise directed by the Architect) in advance of the incorporation in the work of any such materials.

C. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

D. The observation of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract as herein prescribed by the plans and specifications.

E. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, or obligate the Architect to make final acceptance.

End of Section

Section 32 17 24

SIGNS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within SECTION 01 - GENERAL REQUIREMENTS that are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section shall include: Labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The work covered under this Section of the Specifications includes furnishing all plant, labor, equipment, appliances and materials, and performing all operations in connection with the furnishing and placing of the pavement marking as indicated on the drawings and as herein specified.
2. Furnishing and installing appropriate signs, of the type specified and at the locations shown on the Drawings or as indicated by the Architect in conformity with these specifications.
3. Install handicap-parking signs as indicated on the drawing and all other parking instructional signs and gates as specified by the manufacturer's installation instructions.

B. Related Sections include the following:

1. Section 31 00 00 "Earthwork" for soil materials, excavating, backfilling, and site grading.
2. Section 32 00 00 Bituminous Concrete Pavement Curbing and Edging for placement of vertical granite curbing and paving of roadways and walkways.

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – Submittals Procedures for submittal provisions and procedures.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified sign installer whose work has resulted in successful establishment signs.

1. Installer's Field Supervisions: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress.

1.5 REFERENCE STANDARDS

A. All work shall conform to the Commonwealth of Massachusetts, Massachusetts Highway Department, Standard Specifications for Highways and Bridges, hereinafter referred to as the Standard Specification, section 840 and 860. Excavation and backfill shall conform to the Standard Specification, section 140.

B. Traffic Sign work under this item shall conform to the relevant provisions of the MHD Standard Specifications, and the Manual on Uniform Traffic Control Devices.

1.6 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage to existing signs prior or during removal and resetting.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Traffic Signs

1. Materials for all sign panels shall be aluminum panels Type A-1 with high intensity Type III reflective sheeting in accordance with the relevant provisions of Section 828 Traffic Signs of the “Standard Specifications.”
2. Sign supports and foundations shall be in accordance with the details and MUTCD as indicated on the Contract Drawings and Section 840 of the “Standard Specifications.”

PART 3 - EXECUTION

3.1 INSPECTION

A. All materials and each part or detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Owner).

B. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examine prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed, will be at the Contractor’s expense.

C. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor’s expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of the materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks (or as otherwise directed by the Architect) in advance of the incorporation in the work of any such materials.

D. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

E. The inspection of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract as herein prescribed by the plans and specifications.

F. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, or obligate the Architect to make final acceptance.

G. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any time, prior notice shall be given to the Architect before resumption of the work.

3.2 EXECUTION

A. Sign fabrication and erection shall be in accordance with the relevant requirements of Sections 828 and 840 of the "Standard Specifications' and the "Construction Standards."

1. Post foundations, except in ledge, shall be excavated by an auger to the next lines of the outside diameter of the footing without disturbing the soil around or below the excavation.

B. The Contractor shall mark the location of all on-site signs and shall obtain the approval of the Architect before any signs are installed.

C. Signs located in areas subject to pedestrian traffic shall be mounted with a minimum 7-foot clearance to the bottom of the sign. The Contractor shall install the sign types and posts at the locations shown on the Contract Drawings.

D. Signs shall be mounted at right angles to the direction of, and facing, the traffic they are intended to serve. The sign panel shall be located a minimum of one foot from the curb line or edge of pavement.

End of Section

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Section 32 31 14

BLACK VINYL CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Installation of fences, gates, framework, fabric, and accessories.
2. Excavation for post bases.

1.2 RELATED REQUIREMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related sections include the following:

1. Section 03 00 00 - Cast in Place Concrete
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 REFERENCES

A. ASTM Standards:

1. A392 – Zinc coated fence fabric (Class –1)
2. A491 – Aluminum Coated (Table 3)
3. F668 – PVC Coating (Class - 2a)
4. F934 – Color Black

B. Federal Standard (FS) RR-F-191 - Fencing, Wire and Post, Metal.

1.4 QUALITY ASSURANCE

A. Installation: ASTM F567

B. Qualifications: The foreman and laborers shall be thoroughly trained and experienced in the skills required to complete fence and gate, be completely familiar with the design and application of the work, be present at all times during the work and perform the work. The foreman shall have no less than 5 years

minimum proven experience in the required installation techniques and desired results. Submit list of installations, indicating location, Owner, Architect/Engineer, date of installation, Contractor, and setting bed, for approval by the Architect.

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01. Submit shop drawings for fence and gates and for all of their components.

B. Include layout, spacing of components, accessories, fittings, anchorages, and schedule of components.

C. Submit manufacturer's installation instructions under provisions of Division 01.

D. Under provisions of Division 01, submit sample of fence fabric finish, color and gauges. Sample size to be 6" x 12" minimum.

PART 2 – PRODUCTS

2.1 GENERAL

A. Fabric, posts, gate frames, braces, rails, stretcher bars, truss rods, and tension wire shall be of steel. Gate hinges, post caps, stretcher bar bands, and other parts shall be of steel, malleable iron, ductile iron, or equal except that post tops and rails ends may be of aluminum. The manufacturer shall supply a notarized mill certification that all materials used have been tested and fully comply with the guidelines specified herein.

B. Temporary Construction Fence shall be 6’ ht chain link fence. Powder coating or painting is NOT required.

2.2 FRAMEWORK AND POSTS

A. Framework and posts shall be Type 2 round post, steel pipe cold-formed and welded per ASTM F1043, Group IC, with a minimum yield strength of 50,000 psi. The external zinc coating shall be Type B, zinc with polymer film, 0.90 oz/sq. ft. minimum zinc coating with a chromate conversion and a verifiable polymer film. The internal coating shall be Type B, zinc 0.90 oz./sq.ft. minimum or Type D, zinc pigmented, 81% nominal coating with 0.30 mils minimum thickness. Gate framework joints shall be welded and coated in accordance with Practice A780, employing zinc-rich paint.

B. Framework and posts shall be sized as follows:

1. End, Corner, and Pull Post. Galvanized steel, minimum pipe sizes and weights as follows:
   a. Up to 6-foot fabric height: 2.375 – inch OD pipe, 3.12 lbs/lin. Ft. minimum.
   b. 7 and 8-foot fabric heights: 2.875-inch OD pipe, 4.64-lbs/lin. Ft. minimum.
   c. Maximum spacing 10’-0” On Center.
   d. 10-foot to 12-foot heights: 4-inch OD pipe, 6.56 lb/linear foot.
2. Line Posts. Galvanized steel, minimum pipe sizes and weights as follows:
   a. Up to 6-foot fabric height: 1.90-inch OD steel pipe, 2.28-lbs./lin. Ft.

minimum.

b. 7 and 8- foot fabric height: 2.375-inch OD steel pipe, 3.12 lbs./lin. Ft. minimum

c. Maximum Spacing 10'-0" On Center.

d. 10-foot to 12-foot heights: 2.875-inch OD pipe, 4.64 lb/linear foot.

3. Gate Posts. Galvanized steel, nominal gate widths, minimum pipe sizes and weights as follows:

   a. Up to and including 6 feet height with up to 4 foot gate leaves: 2.375 OD pipe minimum.

   b. Up to and including 6 feet height with over 4 foot up to 10 foot gate leaves: 2.875 inch OD pipe minimum.

   c. Up to and including 6 feet height with over 10 feet up to 18 foot gate leaves: 4" OD pipe minimum.

   d. Over 6 feet up to 12 feet height with up to 6 foot gate leaves: 2.875" OD pipe minimum.

   e. Over 6 feet up to 12 feet height with over 6 feet up to 12 foot gate leaves: 4" OD pipe minimum.

   f. Over 6 feet up to 12 feet height with over 12 feet up to 18 foot gate leaves: 6.625" OD pipe minimum.

4. Rails (Top, middle, and bottom rails): galvanized steel, manufacturer's longest lengths joined by seven (7") long sleeves, rail shall run continuously along top of fence. Bottom rail shall be joined at line posts with boulevard clamps. Minimum pipe sizes and weights as follows:

   a. 1.66-inch OD pipe, 1.84 lbs. /lin. Ft. minimum.

2.3 FITTINGS

A. All fittings to be PVC thermally fused color coated having a minimum thickness of 0.006" per ASTM F626. PVC color to match fabric and framework. Moveable parts, nuts and bolts to be field coated with PVC liquid touch up after installation.

1. Couplings: Expansion type, approximately six inches (6") long, install one sleeve for each 500 foot run. Standard couplings are installed at each rail end to form one continuous top rail.

2. Attaching Devices: Provide fittings for attaching top rail securely to each gate corner pull and end post.

3. Sleeves: Galvanized steel pipe not less than six inches (6") long and with inside diameter not less than ½ inch greater than outside diameter of the post pipe. Provide steel plate closure welded to bottom of sleeve of width and length not less than one inch (1") greater than outside diameter of sleeve.

4. Post Brace assembly: Manufacturer's standard adjustable braces at end of gateposts and at both sides of corner and pull posts. Provide horizontal brace located at mid-height of fabric. Use same material as top rail for brace and truss to line posts with 3/8 inch diameter galvanized steel truss rods and adjustable tightener.

5. Post Caps: Galvanized steel, weather-tight closure cap for each tubular post. Furnish caps with openings to permit passages of top rail.

6. Rail ends: Galvanized pressed steel per ASTM F626, for connection of rails to post using a brace band.
7. Tension Bars: galvanized steel, one-piece lengths equal to full height of fabric, with minimum cross-section of 3/16 inch x ¾ inch per ASTM F626. Provide tension bar for each gate and end post, and two for each corner and pull post. Stretcher Bar Bands will be manufacturer's standards.
8. Gate Cross-Bracing: 3/8 inch diameter galvanized steel truss rods and adjustable tightener.
9. Wire ties: 9 gauge galvanized steel tie wire for attachment of fabric to line posts and rails. Pre-formed hog ring ties to be 9 gauge galvanized steel or aluminum for attachment of fabric to tension wire. Tie wire and hog rings PVC coated and in compliance with ASTM F626. Color to match fabric color.
10. Truss rod assembly: Galvanized steel minimum 5/16" diameter truss rod with pressed steel tightener, in accordance with ASTM F626.
11. Carriage bolts and nuts: Galvanized of commercial quality

2.4 FABRIC

A. All general site fence fabric shall consist of No. 9 gauge (0.148 inch core), 2-inch diamond mesh except for the following: **Six (6) gauge wire for backstop fencing; Eleven (11) gauge wire, 1 ¾" diamond mesh for Tennis Court Fencing. All fabric shall receive top and bottom knuckled selvage.** Public side of fabric shall be installed in accordance with the owner's directions. Tennis fabric shall be installed on the court side. The height of the fabric shall be one piece.

1. Galvanized/Aluminum Coated Fabric: All materials used shall conform to the requirements of ASTM A 392 Class 2, or ASTM A491. Except aluminum alloy items, shall conform to ASTM-B211, B221 and B429.
2. Polyvinyl Chloride (PVC) Coated Fabric: fence fabric shall be zinc coated in accordance ASTM A392 Class 1 or aluminum-coated in accordance with ASTM A 491 (Table 3). PVC coating shall be applied in accordance with ASTM F668 Class 2a. The color of the fabric shall be black and in accordance with ASTM F934.

2.5 SWING GATES

A. Fabricate chain link swing gates in accordance with ASTM F900. Gate frame to be of welded construction. Weld areas to be protected with zinc-rich paint per ASTM A780 then over coated with liquid PVC to match frame. The gate frame members are to be spaced no greater than 8' 0" apart horizontally or vertically. Exterior members to be 1.900" OD pipe, interior members when required shall be 1.660" OD pipe. Framing and chain link fabric shall match specification of fence system. Fabric to be stretched tightly and secured to vertical outer frame members using tension bar and tension bands spaced 12" on center and tied to the horizontal and interior members using 9 gauge galvanized steel ties.

B. Hinges, hot dip galvanized pressed steel or malleable iron, structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180 degrees.

C. Latch: Galvanized forked type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.

D. Double gates: Provide galvanized drop rod with center gate stop pipe or receiver to secure inactive leaf in the closed position. Provide galvanized pressed steel locking latch, requiring one padlock for locking both gate leaves, accessible from either side.

E. Keeper to secure open leafs: Provide galvanized gate hold back keeper for each gate leaf over 5' wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.

F. Latch, hinges, moveable parts may be field coated with liquid PVC.

2.6 CHAIN LINK INTERNAL TRACK ALUMINUM CANTILEVER SLIDE GATE

A. Aluminum cantilever slide gates shall be of the internal roller design per ASTM F1184 Type II Class 2. Cantilever slide gate to be constructed of PVC color coated ASTM B221 aluminum members welded and designed for maximum structural integrity. Vertical external and internal members minimum 2" square spaced maximum 8'-0" on center. Gates having fabric greater than 8'-0" in height require a horizontal member. The top horizontal member shall be a one-piece precision extruded structural member having an integral enclosed track. Bottom horizontal member to be minimum 2" x 4". Adjustable diagonal trusses shall be installed in each gate panel to transfer the alternating forces as the gate slides. The gate opening portion shall be filled with chain link fabric stretched taut and secured to the frame members. Chain link fabric shall match the fence system specification. The overall gate structure shall be a minimum of 40% larger than the gate opening to support the cantilevered portion of the gate in the closed position with minimum deflection per ASTM F1184. The minimum 40% back frame does not require fence fabric. Single leaf cantilever design for openings larger than 30'-0" up to 40'-0" shall be fabricated by welding together two horizontal top structural/track members creating a dual track system. Single track gates up to 30'-0" opening require two support posts and two internal truck assemblies. Dual track gates over 30'-0" up to 40'-0" require two sets of dual posts and four internal truck assemblies.

B. Internal truck assemblies shall be capable of swiveling to accommodate gate movement and ensure full contact of the four support wheels and two guide wheels to the internal track surface. The galvanized steel truck assembly post bracket, truck assembly vertical support axle as well as the support wheels shall be designed to handle static and dynamic forces required to support and operate the gate. The truck assembly, support axle and internal wheels shall be comprised of stainless steel or galvanized steel components.

C. Galvanized steel bottom guide roller brackets containing two 3" rubber wheels shall be supplied to keep the bottom of the gate plumb and in proper alignment.

D. Single gates shall be supplied with a galvanized steel latch mechanism capable of securing the gate with a padlock accessible from either side. Double gates to have galvanized drop rod to hold inactive leaf and a latch mechanism capable of securing the gate with a padlock accessible from either side. Provide drop rod stop pipe or receiver to engage center drop rod.

E. Cantilever gate posts shall be 4" OD PVC coated. Single leaf cantilevers up to 30'-0" require three 4" OD posts, dual track single leaf cantilevers over 30'-0" up to 40'-

0" require two sets of pre-fabricated dual 4" OD support posts and a 4" OD latch post. The gate is supported in the center of the dual posts.

2.7 POST SETTING MATERIALS

A. Concrete: As specified in Section 03 30 00.

B. Drive Anchors: Galvanized ASTM A36 steel drive anchor angle blades, 1.25" x1.25" x 30" long secured to post with a pressed steel galvanized shoe clamp.

PART 3 – EXECUTION

3.1 FENCE INSTALLATION:

A. Install new fabric, as indicated on drawings; accessories in accordance with ASTM F567.

B. Provide dimensions as shown and space line posts at intervals indicated.

C. Excavation: Excavate holes for concrete with vertical sides in cylindrical form.

D. Setting Posts:

1. Remove loose and foreign materials from sides and bottom of holes, and moisten soil prior to placing concrete.
2. Center and align posts.
3. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
4. Check each post for vertical and top alignment, and hold in position during placement.
5. Trowel tops of footings, and slope or dome to direct water away from posts.
6. Keep exposed concrete surfaces moist for at least seven (7) days after placement.

E. Concrete Strength:

1. Allow concrete to attain at least 75 percent of its minimum 28 day strength before rails, tension wire, and fabric are installed.
2. Do not, in any case, install such items in less than seven (7) days after placement of concrete.
3. Do not stretch and tension fabric and wire until concrete has attained its full design strength.
4. Provide top rail through line post tops and splice with six inch (6") long rail sleeves.

F. Chain link fence shall have continuous top and bottom rails. Top and bottom edge of fence fabric shall have knuckled edges. Fabric shall be stretched uniformly taunt and tight as possible, true to line and grade and complete in all details. Install tension bars at corners.

G. All chain link fence fabric shall be fastened on the outside of the posts unless directed otherwise by the Owner or otherwise indicated in this specification. The fabric shall be properly stretched and securely fastened to the posts, and between

posts the top and bottom of the fabric shall be fastened to end and corner posts with tension bars and stretcher bars bands spaced at one (1) foot intervals.

H. All fabric shall be aligned so that top row of the fabric mesh is tied to the top rail twelve inches (12") on center and so that the bottom of the fabric mesh stand two inches (2") maximum above finish grade or as indicated on plans, and that the bottom row of the fabric mesh is tied to the bottom rail every twelve inches (12") on center. When applicable, all fabric shall be tied to the middle rail at twelve inches (12") on center.

I. All fabric shall be fastened to all line posts and horizontal rails with 0.020" thickness, 200/300 series stainless steel ½" wide bands, with a minimum breaking strength of 850 lbs., ½" band capacity ear-lokt design buckles to be manufactured with 0.050" thick material, 201/301 series stainless steel. All bands shall be pulled tight and raw ends of steel bands shall be secured in buckle by folding ear tabs around steel bands as per manufacturer's recommended installation procedure. No sharp edges shall protrude from band-it buckles. Band will be PVC coated, color to match fabric and framework.

J. Perimeter Fencing and Gates: Install fabric 1-inch above finished grade.

K. Touch up any nicks or scratches of the PVC color coating with liquid PVC paint.

L. Touch up any nicks or scratches on the posts or rails with a manufacturers approved paint.

3.2 GATE INSTALLATION

A. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION

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Section 32 31 20

GREEN TRELLIS FENCE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials and equipment to include Green Trellis Fencing for the referenced project.

1.2 RELATED REQUIREMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:

1. 03 30 00 - Cast-in-Place Concrete
2. 31 00 00 - Earthwork
3. 32 13 13 – Site Concrete
4. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
5. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
6. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 SUBMITTALS

A. Changes in specification are only upon written approval by Owner.

B. Shop Drawings: Shall consist of dimensions, sizes, finishes and post foundations. Shop drawings shall be designed and detailed under the direct supervision of a licensed in house Professional Engineer. The Professional Engineer shall be present during the time the design and detailing is completed unless all details are included on the approval drawings bearing his/her seal.

C. Product Data: Manufacturer's certification indicating material compliance and installation.

D. Samples: Color selections for polyester powder coated finishes. If requested, samples of fence components delivered to Owner.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):
    a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
    b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

PART 2 - PRODUCTS

2.1 ORNAMENTAL FENCE

A. Green Trellis Fence shall be Powder Coated Green Steel. Trellis grids shall be 3" max. spacing. Posts shall be a minimum of 4" sq. Post caps shall be flat style and constructed of aluminum or steel to form a weather-tight closure. All posts, caps, and fence panels shall be polyester coated individually after fabrication to thoroughly coat all surfaces for additional corrosion protection. All components shall enter a 5 stage in line cleaning process to prepare the galvanized surfaces for complete adhesion of the finish coat. Components shall be given a TGIC polyester resin powder coating applied by the electrostatic spray process to 3.0 mil thickness. The finish shall be baked in an oven for 15-20 minutes at a temperature ranging from 400°F. Warranty shall be a minimum of 15 years.

B. Acceptable manufacturers include the following:
    1. GREENscreen Freestanding Trellis Fence; Los Angeles, CA; phone: 800-450-3494, fax: 310-837-0523, www.greenscreen.com
    2. McNichols Eco-Mesh, Trellis System; P.O. Box 30300, Tampa, FL 336330-330; phone 800-237-3820, fax: 813-288-1828, sales@mcnichols.com
    3. VertiGreen 3D Trellis System, Tournesol Siteworks LLC; 42326 Albrae St., Freemont, CA 94538; phone: 800-542-2282, fax: 510-471-6243
    4. Or equivalent.

2.3 SETTING MATERIALS

A. Concrete: Refer to Division 03, Section 03 30 00 - Cast in Place Concrete.

B. Post: Posts shall be embedded into concrete footings as shown on the plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Fence layout to be surveyed and staked by Contractor on finish grades.

3.2 FENCE INSTALLATION

A. Install the terminal posts for the gates per manufacturer's instructions if included.

B. Set post uniformly at 6’-0” center to center unless otherwise indicated.

C. Set posts in concrete having a diameter 4 times the diameter of the post.

D. Check each post for vertical and top alignment.

E. Attach panels to posts per manufacturer’s instructions. All areas of paint or powdercoated surfaces scratched, dented or otherwise defected by installation shall be corrected by the Contractor at no expense to the Owner.

F. Install and secure specified post tops

3.4 CLEANING

A. Clean up debris and remove from the site.

END OF SECTION

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Section 32 32 00

SEGMENTAL RETAINING WALL

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "Or approved equal" applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an approved equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.2 SCOPE

A. Work includes furnishing and installing segmental retaining wall (SRW) units to the lines and grades designated on the construction drawings or as directed by the Architect. Also included is furnishing and installing appurtenant and incidental materials required for construction of the retaining walls as shown on the construction drawings.

1.3 REFERENCES

A. The following standards and specifications listed below form a part of this specification where applicable.
   1. Segmental Retaining Wall Units.
      a. ASTM C 140 - Sampling and Testing Concrete Masonry Units.
      b. ASTM C 94 – Ready-Mixed Concrete
      c. ASTM C 1372 – Segmental Retaining Wall Units
   2. Geosynthetic Reinforcement.
      a. ASTM D 4595 -Tensile Properties of Geotextiles by the Wide-Width Strip Method.
      b. ASTM D 5262 -Test Method for Evaluating the Unconfined Creep Behavior of Geosynthetics.
      c. GRI:GG1 - Single Rib Geogrid Tensile Strength.
      d. GRI:GG5 - Geogrid Pullout.
   3. Soils.
      a. ASTM D 698 - Moisture Density Relationship for Soils, Standard Method.
      b. ASTM D 422 - Gradation of Soils.
      c. ASTM 4318 - Atterberg Limits of Soil.

4. Drainage Pipe.
   a. ASTM 3034 - Specification for Polyvinyl Chloride (PVC) Plastic Pipe.
   b. ASTM D1248 - Specification for Corrugated Plastic Pipe.
5. Where specifications and reference documents conflict, the Architect shall make the final determination of applicable document.

1.4 SUBMITTALS

A. Material Submittals.
   1. The Contractor shall submit manufacturers' certifications two weeks prior to start of work stating that the intended SRW units and geosynthetic reinforcement meet the requirements of this specification.
   2. Submit representative block samples for selection of color and texture of exposed wall face(s) to the Architect. Desired exposed face and cap color samples are the color indicated on the plans

B. Design Submittal:
   1. The Contractor shall submit two sets of detailed design calculations and construction drawings for review and acceptance at least two weeks prior to the beginning of wall construction. All calculations and drawings shall be prepared and sealed by a Professional Engineer experienced in SRW wall design and licensed in the Commonwealth of Massachusetts.

1.5 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check materials upon delivery to assure that specified type and grade of materials have been received and proper color and texture of SRW units have been received.

B. Contractor shall prevent excessive mud, wet concrete, epoxies, and like materials that may affix themselves by unintentional contact with SRW materials.

C. Contractor shall store and handle materials in accordance with manufacturer's recommendations.

D. Contractor shall protect materials from damage. Damaged materials shall not be incorporated into the retaining wall.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Wall units shall be Re-Con, Redi-Rock, Strong Stone LLC or equivalent.

B. Wall units shall be made with Ready-Mixed concrete in accordance with ASTM C94, latest revision, and per the following chart:

Climate	Air Content	28 Day Compressive Strength, psi	Slump*
Negligible	1½%-4½%	4000	5” ±1 ½”
Moderate	3%-6%	4000	5” ±1 ½”
Severe	4½%-7½%	4000	5” ±1 ½”

*Higher slumps are allowed if achieved by use of appropriate admixtures. Notwithstanding anything stated above, all material used in the wall units must meet applicable ASTM and local requirements for exterior concrete.

C. Exterior block dimensions shall be uniform and consistent. Maximum dimensional deviations shall be 1% excluding the architectural surface. Maximum width (face to back) deviation including the architectural surface shall be 1.0 inch.

D. Exposed face shall be finished as specified. Other surfaces to be smooth form type. Dime-size bug holes on the block face may be patched and/or shake-on color stain can be used to blend into the remainder of the block face.

E. SRW units shall be machine formed, Portland Cement concrete blocks specifically designed for retaining wall applications.

F. Color of SRW units to be selected by the Architect. See Materials submittal requirements for further information in selection of applicable color(s).

G. SRW units shall be solid through the full depth of the unit.

H. For any corners shown on the construction plans, SRW units shall be capable of providing overlap of units on each successive course so that walls meeting at corner are interlocked and continuous. SRW units that require corners to be mitered shall not be allowed.

I. SRW units shall be capable of providing a split face, textured surface for all vertical surfaces that will be exposed after completion of wall, including any exposed sides and backs of units.

J. SRW 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. Cracking or excessive chipping is ground for rejection. Units showing cracks longer than 1/2" shall not be used within the wall. Units showing chips visible at a distance of 30 feet from the wall shall not be used within the wall.

K. Concrete used to manufacture SRW units shall have a minimum 28-day compressive strength of 3,000 psi and a maximum moisture absorption rate, by weight, of 8% as determined in accordance with ASTM C 140. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C140 with the exception that the Coupon shall be taken from the least dimension of the unit of a size and shape representing the geometry of the unit as a whole.

L. SRW units' molded dimensions shall not differ more than + 1/8 inch from that specified, except height which shall be + 1/16 inch as measured in accordance with ASTM C140.

2.2 SEGMENTAL RETAINING WALL UNIT CONNECTION PINS

A. SRW units shall be interlocked with connection pins, of the material, size, and dimension as recommended and by the wall system manufacturer.

2.3 GEOSYNTHETIC REINFORCEMENT

A. Geosynthetic reinforcement shall consist of geogrid or geotextile 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.

B. The type, strength, and placement location of the reinforcing geosynthetic shall be determined by the Wall Design Engineer, and shown on the design submittal.

2.4 LEVELING PAD

A. Material for leveling pad shall consist of compacted granular fill and shall be a minimum of 6 inches in depth. Lean concrete with a 28 day compressive strength of 200-300 psi and three 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 SRW unit.

B. Free Draining Backfill material shall be washed stone and shall be placed to a minimum of 1’ width behind the back of the wall and shall extend vertically from the Leveling Pad to an elevation 6” below the top of wall.

2.5 DRAINAGE AGGREGATE

A. Drainage aggregate shall be angular, clean stone as specified by the Wall Design Engineer

2.6 DRAINAGE PIPE

A. The drainage collection pipe shall be a perforated or slotted PVC, or corrugated HDPE pipe. The drainage pipe shall be wrapped with a geotextile to function as a filter.

B. Drainage pipe shall be manufactured in accordance with ASTM D 3034 and/or ASTM D 1248.

2.7 REINFORCED (INFILL) SOIL

A. The reinforced soil material shall be free of debris. Reinforced material shall consist of the Granular Fill as indicated in Earthwork (Section 31 00 00) or material as required by the wall designer.

B. The maximum particle size of poorly-graded gravels (GP) (no fines) should not exceed 3/4 inch unless geosynthetic strength is reduced to account for additional installation damage from particles larger than this maximum.

C. The plasticity of the fine fraction shall be less than 20.

PART 3 – DESIGN PARAMETERS

3.1 SOIL

A. The following soil parameters shall be for preparation of final design documents by the Wall Design Engineer, unless otherwise directed by the Architect.

Strata	Unit Weight (pcf)	Internal Friction Angle (degrees)	Cohesion (c) (psf)
Reinforced Fill	125	30	0
Retained Soil	125	30	0
Foundation Soil	125	30	0

B. The design of the permanent wall system shall include an allowance of at least a two foot (2 ft) depth uniform vertical soil surcharge loading where walls retain roadway fills. This provision is applicable when the distance from the face of wall to the edge of road is less than the design wall height.

C. The wall system may also be designed to account for reasonable temporary surcharge conditions during construction, such as those due to stockpiling of soil or other construction materials.

D. The construction drawings shall indicate the design limitations of the wall system.

E. Should the actual soil conditions observed during construction differ from those assumed for the design, the Wall Design Engineer shall review the design.

3.2 DESIGN

A. The design provided by the Contractor and prepared by their Wall Design Engineer shall consider the internal and local stability of the reinforced soil mass and shall be in accordance with acceptable engineering practice and these specifications.

B. The Wall Design Engineer shall confirm that the global stability limit states of sliding, overturning, and the allowable bearing pressure on foundation soil(s) have not been exceeded for the design conditions. Minimum factors of safety for design of permanent conditions are as follows:

Overturning	2.0
Sliding	1.5
Bearing Pressure	2.0

C. Where other site development features are to be installed adjacent to walls by the Contractor, the design of the wall system shall be developed to accommodate the potential for geotextile penetrations, such as fence and/or guardrail posts.

D. Note that as located the backfill is sloped to a parking area.

3.3 LEVELING PAD PLACEMENT

A. Leveling Pad shall be placed as shown on the construction drawings.

B. Leveling Pad shall be placed on undisturbed native soils or suitable replacements fills.

C. Leveling Pad shall be compacted to 95% of standard proctor or 90% of modified proctor to ensure a level, hard surface on which to place the first course blocks. Pad shall be constructed to the proper elevation to ensure the final elevation shown on the plans.

D. Leveling Pad shall have a 6 inch minimum depth for walls under 8 feet in height and a 12 inch minimum depth for walls over 8 feet. Pad dimensions shall extend beyond the blocks in all directions to a distance at least equal to the depth of the pad or as designed by Engineer.

E. For steps and pavers, a minimum of 1" - 1 ½" of free draining sand shall be screeded smooth to act as a placement bed for the steps or pavers.

PART 4 - CONSTRUCTION

4.1 INSPECTION

A. The Architect 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.

4.2 EXCAVATION

A. 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 Architect, at the Contractor's expense.

B. 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 and/or adjacent structure or utility support, if required, is the design and installation responsibility of the Contractor.

4.3 FOUNDATION PREPARATION

A. Following the excavation, the foundation soil shall be examined by the Architect 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 Architect.

B. Foundation soil shall be proof rolled or otherwise compacted to 95% modified Proctor density (ASTM D 1557) and inspected by the Architect prior to placement of leveling pad materials.

4.4 LEVELING PAD CONSTRUCTION

A. Soil 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 1/2 to 1/4 inch of the leveling pad. Compaction will be with mechanical plate compactors to achieve 95% of maximum modified Proctor (ASTM D 1557) density.

4.5 SRW UNIT INSTALLATION

A. All SRW units shall be installed at the proper elevation and orientation as shown on the wall profiles and details on the construction plans or as directed by the Architect. The SRW 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.

B. First course of SRW 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.

C. Clean all excess debris from top of units and install next course.

D. Install next course of wall units on top of base row. Position blocks to be offset from seams of blocks below. Blocks shall be placed fully forward so knob and groove are engaged. Check each block for proper alignment and level. Backfill to 12 inch width behind block with Free Draining Backfill. Spread backfill in uniform lifts not exceeding 9 inches. Employ methods using lightweight compaction equipment that will not disrupt the stability or batter of the wall. Hand-operated plate compaction equipment shall be used around the block and within 3 feet of the wall to achieve consolidation. Compact backfill to 95% of standard proctor (ASTM D 698, AASHTO T-99) density within 2% of its optimum moisture content.

E. Layout of curves and corners shall be installed in accordance with the plan details or in general accordance with SRW manufacturer's installation guidelines. Walls meeting at corners shall be interlocked by overlapping successive courses.

F. Install each subsequent course in like manner. Repeat procedure to the extent of wall height.The wall face cant (batter) shall not differ more than $\pm$ 2 degrees from that specified.

G. Allowable construction tolerance at the wall face is 2 degrees vertically and 1 inch in 10 feet horizontally.

H. All walls shall be installed in accordance with local building codes and requirements.

4.6 GEOSYNTHETIC REINFORCEMENT PLACEMENT

A. All geosynthetic reinforcement shall be installed at the proper elevation and orientation as shown on the wall profiles and details on the final construction plans or as directed by the Architect

B. At the elevations shown on the final plans, the geosynthetic reinforcement shall be laid horizontally on compacted infill and on top of the concrete SRW units. Embedment of the geosynthetic in the SRW units shall be consistent with SRW 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.

C. Geosynthetic reinforcement layers shall be one continuous piece for their entire embedment length. Overlap of the geosynthetic in the design strength direction (perpendicular to the wall face) shall not be permitted.

D. 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).

E. The geosynthetic reinforcement shall be in tension and 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 six inches of fill.

4.7 DRAINAGE MATERIALS

A. Drainage aggregate shall be installed to the line, grades, and Sections shown on the final plans. Drainage fill shall be placed to the minimum thickness shown on the construction plans between and behind units.

B. Drainage collection pipes shall be installed to maintain gravity flow of water outside the reinforced soil zone. Unless shown otherwise on the plans, drainage collection piping shall daylight into a storm sewer manhole or along a slope at an elevation lower than the lowest point of the pipe within the aggregate drain.

4.8 BACKFILL PLACEMENT

A. The reinforced backfill shall be placed as shown in the construction plans in the maximum compacted lift thickness of 12 inches and shall be compacted to a minimum of 95% of modified Proctor density (ASTM D 1557) at a moisture content within 2% 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 SRW units.

B. Backfill placement shall commence at the back of the wall and progress towards the retained material.

C. Only hand-operated compaction equipment shall be allowed within 3 feet of the front of the wall face. Compaction within the 3 feet behind the wall face shall be

achieved by at least three (4) passes of a lightweight mechanical tamper, plate, or roller.

D. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to direct water runoff away from the wall face.

E. 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 surface 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.

4.9 SRW CAPS

A. SRW caps shall be properly aligned and attached to underlying units with a suitably flexible, high-strength concrete adhesive. Rigid adhesives or mortar will not be accepted.

B. Caps shall overhang the top course of units by 3/4 to 1 inch. Slight variation in overhang is allowed to correct alignment at the top of the wall.

4.10 CONSTRUCTION ADJACENT TO COMPLETED WALL

A. The Contractor is responsible for ensuring that construction 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 three feet behind the back of the wall face. 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

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Section 32 32 10

BOULDER PLACEMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Layout and Excavation of Areas
2. Placement of Boulders in Landscape
3. Placement of Boulders in Pavement

1.2 RELATED REQUIREMENTS

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

B Related Sections: The following sections contain requirements that relate to this section.

1. Section 31 00 00 – Earthwork
2. Section 03 00 00 - Cast in Place Concrete
3. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 QUALITY ASSURANCE

A. The Landscape Architect reserves the right to inspect all materials and placement of materials for compliance with specifications, and to reject unsatisfactory or defective materials and/or layout at any time during progress of work.

B. Do not make substitutions without written approval. If specified landscape material is not available, obtain approval for substitution from the Landscape Architect.

1.4 SUBMITTALS

A. A sample Boulder be selected by the Landscape Architect through the Contractor to show the texture, finish, and anticipated range of color and size to be supplied and shall be stored on site.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Product will be stored in location specified by General Contractor.

PART 2 - PRODUCTS

2.1 BOULDER IN LANDSCAPE

A. Boulder sizes per plans and details.

B. Boulder colors will be grey and tan in color. Variations in color shall be approved by the Landscape Architect.

C. Boulders will be more rounded in form. See figures 2.1-2.2 for photos of the range of acceptable boulder shapes and colors.

Figures 2.1 and 2.2

D. Texture and finish shall be within the range of samples approved by the Landscape Architect.

E. Boulders from site can be re-used upon approval from Landscape Architect.

PART 3 - EXECUTION

3.1 PLACEMENT OF BOULDER

A. Boulder shall be placed on compacted sand gravel fill per the drawings.

A. Boulder will be placed as indicated on the plans.

B. Boulder shall be buried in accordance with the drawings and details.

END OF SECTION

Section 32 50 00

STORMWATER POLLUTION PREVENTION PLAN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is only a portion of the Contract Documents. All of the Contract Documents, including Division 1 General Requirements, apply to this section.

1.2 DESCRIPTION OF WORK

A. This Section specifies requirements for implementation of the Storm Water Pollution Prevention Plan (SWPPP), which shall be provided by the Contractor prior to construction.

B. The storm water pollution prevention measures contained in the SWPPP are the minimum required by US Environmental Protection Agency (EPA). The Contractor shall provide additional measures to prevent pollution from storm water discharges in compliance with the NPDES and all other local, state and federal requirements. The Contractor shall be responsible for complying with the provisions of the SWPPP.

C. The Contractor shall NOT begin construction without submitting evidence that a "National Pollution Discharge Elimination System" (NPDES) Notice of Intent governing the discharge of storm water from the construction site for the entire construction period has been filed at least two weeks prior to construction.

D. The Contractor shall conduct the storm water management practices in accordance with local regulations and governing authorities, the Federal NPDES permit requirements and for any enforcement action taken or imposed by Federal or State agencies. The cost of any fines, construction delays and remedial actions resulting from the Contractor's failure to comply with all provisions of local regulations and Federal NPDES permit requirements shall be paid for by the Contractor at no additional cost to the Owner.

E. As a requirement of the EPA's NPDES permitting program, the Owner, each Contractor and Subcontractor shall execute a Contractor's Certification form, a copy of which is included in the SWPPP.

F. Dust control shall be the responsibility of the Contractor and dust control operations shall meet the requirements of the Commonwealth of Massachusetts Department of Environmental Protection 310 CMR 7.09: Air Pollution Control Regulations.

G. Water shall be used to control dust.

1.3 DESCRIPTION OF WORK

A. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 31 25 00 – EROSION CONTROL.

1.4 REFERENCES

A. Guidance Manual—"Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA 832-R-005).

B. Summary of Guidance Manual—"Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA).

C. National Pollution Discharge Elimination System General Permit for Discharges from Construction Activities, February 16, 2012, EPA.

D. Massachusetts Stormwater Management Standards Handbook, February 2008.

E. Massachusetts “Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers, and Municipal Officials” prepared by Department of Environmental Protection (DEP), Reprinted May 2003.

F. Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition, herein referred to as the “Standard Specifications” and related articles.

G. City of Beverly Stormwater and Construction Site Management Ordinance No. 86, 5, December 2008

1.5 SUBMITTALS

A. The Stormwater Pollution Prevention Plan.

B. Contractor's Certification for Contractor and each Subcontractor.

C. Copies of Contractor's inspection reports.

D. Names, addresses, and telephone numbers of Contractors and Subcontractors responsible personnel who can be contacted under emergency conditions.

E. A construction schedule which indicates specific activities related to the SWPPP.

F. A supplemental Plan indicating location of laydown and staging areas, and their incorporation into the SWPPP.

1.6 INSPECTIONS

A. The Contractor will conduct the inspections per the SWPPP. The Contractor will implement any actions to maintain full compliance with the SWPPP.

B. A maintenance inspection report shall be prepared after each inspection, by the Contractor. The Contractor shall identify one individual who will be responsible keeping the site in full compliance with the SWPPP and maintaining an up-to-date copy of the SWPPP onsite.

PART 2 - PRODUCTS

2.1 WATER FOR DUST CONTROL:

A. Water used shall be clean, non-polluted water obtained from sources approved by the Owner and/or Engineer.

PART 3 - EXECUTION

3.1 EROSION CONTROL DEVICES:

A. Erosion Control Devices shall be constructed as shown on the SWPPP and as specified in the plans and specifications.

3.2 STORM WATER POLLUTION PREVENTION PRINCIPLES

A. The following general principles shall be followed by the Contractor during the construction phase:

1. Protect and maintain existing vegetation wherever possible.
2. Minimize the area of disturbance.
3. To the extent possible, route unpolluted flows around disturbed areas.
4. Install mitigation devices as early as possible.
5. Minimize the time disturbed areas are left unstabilized.
6. Maintain siltation control devices in proper condition.

3.3 STORM WATER POLLUTION PREVENTION PLAN

A. The Contract drawings and specifications identify a portion of the required facilities and temporary erosion control devices. The Contractor shall prepare a SWPPP in accordance with NPDES requirements which identifies the location of construction facilities and proposes additional erosion control measures as necessary to minimize pollution. The SWPPP shall include provisions for but not be limited to the following:

1. Construction Trailers
2. Laydown Areas
3. Equipment Storage Areas
4. Stockpile Areas

B. Reproducibles of one or more of the Contract Drawings will be provided to the Contractor to serve as a base for the Contractor's SWPPP.

3.4 APPLICATION – WATER:

A. The application of water shall be under the control of the Contractor at all times. It shall be applied only at the locations, and at such times, and in the amount as may be directed by the Owner. Quantities of water wasted or applied without authorization will not be paid for.

B. The Contractor shall have available and maintain in an operable condition at all times, sufficient equipment for the purpose of applying water for dust control.

C. Watering equipment shall consist of pipelines, tanks, tank trucks, distributors, pumps, meters, hose or other devices, approved by the Owner, which are capable of applying a uniform spread of water over the surface. A suitable device for a positive shut-off and for regulating the flow of water shall be located so as to permit positive operator control.

End of Section

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Section 32 84 00

IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, labor, installation equipment, and technical service to complete construction of automatic irrigation system, as well as the testing and warranty of the system as defined in this Specification and Construction Drawings. Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and fees.
2. Coordination of all utilities.
3. Verification of site conditions.
4. Maintenance during guarantee period.
5. Connection of electrical power supply to the irrigation control system.

1.2 QUALIFICATIONS

A. Qualified irrigation system installers must have a minimum experience of four (4) years with work and products specified herein, including:

1. Two-Wire Controller and Valve Installation
2. Weather-Based and Smart Controllers
3. Solvent Weld and/or Gasket Joint PVC Pipe 2-inches and Greater

1.3 WORK NOT INCLUDED (PROVIDED BY OTHERS)

A. Water Service Point of Connection

1. New building domestic water service to be provided by Plumbing Contractor. Refer to Division 22 PLUMBING. Approximate exterior point of connection location is noted on Construction Drawings.
    a. Equipment requirements:
        1) Backflow Preventer
            a) Size: 2-Inch
            b) Construction: Bronze with Quarter Turn Ball Valve
            c) Ratings: 175 psi Maximum
            d) Manufacturer/Model: Watts Model 009M2-QT-S; or Approved Equal.
        2) Water Meter
            a) Size: 2-Inch
            b) Construction: Bronze
            c) Features: Magnetic Drive with Automatic Meter Register (ARM), Oval Flanges
            d) Manufacturer/Model: Neptune Model T-10; or Approved Equal
        3) Domestic Water Connection
            a) Size: 2-Inch
            b) Construction: Type K Copper
            c) Ratings: Class 100, Type III, SDR 15, Class C
            d) Standards: ASTM B-88

e) Fittings: Wrought Copper, Silver Solder Joint (per ASTM B-828), Non-Corrosive Flux
f) Markings: Manufacturer, ASTM Standards, Size
g) Manufacturer: United States Origin Only

b. Flow and pressure requirements at outdoor point of connection:
1) Flow: Maximum 60 gallons per minute
2) Pressure: 80 pounds per square inch dynamic pressure

B. Electrical Power Source to Indoor Controller
1. New electrical circuits to be provided by Electrical Contractor (Refer to Division 26 ELECTRICAL).
a. Power Requirements for Irrigation Controller
1) 120-Volt, 1-Phase, 60-Hz, 20-Amp
b. Conduits to exterior point of connection

C. Communications to Indoor Controller
1. Communications to be provided by Communications Contractor (Refer to Division 27 COMMUNICATIONS).
a. Communication Requirements for Irrigation Controller
1) Ethernet CAT/5 Cable to Local Area Network

D. Pipe Sleeves
1. Pipe sleeves to be provided by Earthwork Contractor beneath all hardscape, as indicated on Construction Drawings.
a. Pipe sleeve requirements
1) Two (2) parallel 4-inch SDR Class 160 PVC
2) Extend 18 inches beyond edge of hardscape
3) Minimum cover: 24 inches

1.4 RELATED REQUIREMENTS

A. Coordinate with other project trades and refer to overall project Construction Document Specifications and Drawings, including, but not limited to:
1. Division 01 – GENERAL REQUIREMENTS
2. Division 02 – EXISTING CONDITIONS
3. Division 03 – CONCRETE
4. Division 22 – PLUMBING
5. Division 26 – ELECTRICAL
6. Division 27 – COMMUNICATIONS
7. Division 31 – EARTHWORK
8. Division 32 – EXTERIOR IMPROVEMENTS
9. Division 33 – UTILITIES
10. Construction Drawings:
a. IR-1.0 – Irrigation Layout
b. IR-2.0 – Irrigation Details (Sheet 1 of 2)
c. IR-2.1 – Irrigation Details (Sheet 2 of 2)

d. Review all other Project Construction Documents for coordination.

1.5 APPLICABLE STANDARDS AND CODES

A. At a minimum, comply with the following standards and codes:
   1. American Society for Testing and Materials (ASTM)
   2. National Standard Plumbing Code (NSPC)
   3. National Electric Code (NEC)
   4. National Sanitary Foundation (NSF)
   5. Underwriters Laboratories, Inc. (UL)
   6. Occupational Safety and Health Administration (OSHA)

B. Comply with applicable laws, standards, and regulations of the local governing authority. All local laws more stringent than those referenced above shall take precedent.

1.6 SUBMITTALS

A. Submit the following under provisions of Section 01 33 00 - SUBMITTAL PROCEDURES:
   1. Literature: Manufacturer's product data sheets, specifications and installation instructions for materials listed in this Specification (Part 2 – Products).
      a. Product submittals shall be concise (no extraneous pages or sections) and clearly marked to show submitted product model, type, size, etc.
      b. Substitute Product Submittal:
         1) Provide specified product submittals for “an approved equal” to Owner’s Representative for approval.
         2) Alternate products are acceptable when products of equal or better quality and performance are submitted and approved by the Owner’s Representative.
         3) Substitute Product Submittals constitute representation that:
            a) Substitute products have been thoroughly investigated and have been determined to be equal or superior in all respects to that specified.
            b) Substitute products shall provide the same warranties as specified products.
            c) Substitute products are compatible with interfacing items.
            d) Assume responsibility of and guarantee system performance as a result of product substitution, including making all subsequent changes to meet design specifications.
      c. Work shall not commence until all products specified are submitted and approved in a written notification by Owner’s Representative.
      d. All product installed shall be new, without defects, and of quality and performance as specified.
   2. Schedule: Submit Schedule of all products to be furnished hereunder, indicating manufacturer, size, and model.
      a. Ensure that all of the types/styles of products and installation equipment specified herein can be furnished by the manufacturer submitted.
      b. Provide all spare irrigation parts as noted (see Spare Irrigation Parts)

c. Prior to submitting schedule, confirm current site conditions are as provided in the Construction Drawings.

3. Qualifications: Submit qualification package as requested by Owner's Representative. Qualifications package must include:
   a. Two (2) references for similar work performed in last five (5) calendar years.
      1) Contact name
      2) Company Name
      3) Contact Phone Number
      4) Project Name and Location
      5) Brief Project Description

1.7 DELIVERY, STORAGE AND HANDLING

A. Do not deliver materials to the site, until all specified submittals have been submitted to, and approved by, the Owner's Representative.

B. Coordinate with Owner's Representative for temporary storage and staging areas.

C. Protect materials from damage from construction traffic, weather, corrosion, and other causes while stored on-site. Minimize on-site storage as possible.

D. Store and handle all products and materials in compliance with manufacturer instructions and recommendations.

1.8 GUARANTEE AND REPLACEMENT

A. Guarantee entire irrigation system, parts and labor, for one (1) year from official written date of acceptance by Owner's Representative. Provide written warranty showing date of completion and period of warranty prior to request for final payment.

B. System malfunctions occurring during the guarantee period due to defective materials, poor workmanship, or improper adjustment shall be corrected to satisfaction of Owner's Representative at no additional cost to the Owner.
   1. Repair all defects within 10 days of notification from Owner or Owner's Representative.
   2. Repair defects with approved products.

C. First-year spring system start-up and winterization shall be included in system guarantee.

D. Manufacturer warranties shall be provided for all products and materials where such warranties are offered in published product data. Copies of manufacturer warranties are to be included in the Operations & Maintenance Manual (See Operation and Maintenance)

PART 2 - PRODUCTS

2.1 AUTOMATIC IRRIGATION CONTROLLER

A. Controller
   1. Size: 12 inches (tall) x 15 inches (wide) x 6 inches (deep)

2. Construction: Electronic with 120-Volt Input and 24-28 Volt Output, Stainless Steel Wall-Mounted Enclosure
3. Standards: UL-Listed
4. Features: Manual and Automatic Control, Water Budgeting, Cycle-Soak, Sensor Input Terminals, Internal Transformer, Flow Monitoring Capability, Lightning Protection, Remote Control, Two-Wire System with Conventional Wire Retrofit Capability.
5. Manufacturer/Model: Hunter Model ACC-99D; or Approved Equal.

B. External Devices

1. Weather Sensor
   a. Manufacturer/Model: Hunter Solar Sync (Sunlight/ET, Rain, and Temperature)
2. Flow Sensor
   a. Manufacturer/Model: Hunter HFS with FCT-208 Tee
3. Remote Control
   a. Manufacturer/Model: Hunter ROAM, ROAM-XL
4. Decoders & Surge Suppression
   a. Manufacturer/Model: Hunter ICD-100 and ICD-200, with grounding as required (see below)
   b. Manufacturer/Model: Hunter Dual-S Surge Suppressor

C. Outdoor Grounding

1. Size
   a. Wire: 6AWG Bare
   b. Rod: 5/8-Inch Diameter x 12-Foot Long
   c. Plate: 4-Inch x 96-Inch x 1/16-Inch Thick
2. Construction
   a. Wire: Copper
   b. Rod: Copper
   c. Plate: Copper with Loresco PowerSet Ground Enhancement Material Above and Below
3. Ratings: UL-Listed
4. Features: Cadweld Connectors from Wire to Rod, Plate Manufacturer provided Plate Connections, PVC or ADS Drain Pipe and Grate Cover over Rod Plate with Metal Detection

2.2 WIRE

A. Two-Wire (From Controller to Decoders)

1. Size: 14/2 AWG Minimum
2. Construction: Dual Strand Solid Copper Conductors with PVC Insulation and Poly Jacket.
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8

5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model: Coleman Cable #51452; Paige P7072D, P7296D, P7350D, and P7354D; Regency 14/2 and 12/2 Maxi Cable; Hunter Decoder Jacketed; Service Wire Company DEC12/2BE and DEC 14/2BE; or Approved Equal.

B. Conventional Wire (From Decoders to Electric Zone Valves)

1. Size: 14AWG Minimum
2. Construction: Single Strand Solid Copper Conductor with PVC Insulation
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8
5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model: Paige Electric Model P7001D; Service Wire Company UF14, UF12; Regency Wire & Cable 14AWG, 12AWG; or Approved Equal.

C. Wire Splices

1. Type: Direct Burial Wire Splice Kit (All Components Intact)
2. Construction: Lockable Plastic Tube, Pre-Filled with Insulation Gel
3. Ratings: UL-Listed, NEC, Direct Burial and Submersion, up to 600-Volt Potential
4. Manufacturer/Model: 3M DBY-6; Rain Bird DB Series; or Approved Equal.

D. Wire Conduit

1. Size: 1-Inch Minimum
2. Construction: PVC, Solvent Weld
3. Ratings: Schedule 40
4. Fittings: Long Sweep Elbows
5. Manufacturer: Cresline; Certainteed, JM Eagle; or Approved Equal.

2.3 PIPE AND FITTINGS

A. Small Irrigation Mainline and Laterals

1. Size: 2½-Inch Maximum
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld
3. Ratings: Class 200, Type 1120, SDR 21
4. Standards: ASTM D-2241
5. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark.
6. Fittings
   a. For Valves: Schedule 80 PVC Toe Nipples
   b. Other Fittings: Schedule 40 PVC
7. Manufacturer: Cresline; Certainteed; JM Eagle; or Approved Equal.

2.4 ELECTRIC ZONE VALVES

A. Irrigation Zone Valve
   1. Size: 1-Inch, 1½-Inch, and 2-Inch
   2. Construction: Plastic Globe Valve with Reinforced Nylon or Fiberglass Body
   3. Ratings: 200 psi
   4. Features: Manual Bleed Screw, Flow Control, Pressure Regulation, and Filter
   5. Manufacturer/Model: Hunter ICV-G-FS with Filter Sentry; or Approved Equal

B. Master Valve
   1. Size: 2-Inch (40 to 150 gpm)
   2. Construction: Brass Globe Valve
   3. Ratings: 220 psi
   4. Features: Manual Bleed Screw, Flow Control, Pressure Regulations, and Filter
   5. Manufacturer/Model: Hunter ICV-G-FS with Filter Sentry; or Approved Equal

2.5 ISOLATION VALVES

A. Small Mainline
   1. Size: 2½-Inch and Smaller
   2. Construction: Bronze, Gate Valve
   3. Ratings: 200 psi
   4. Features: Steel Cross Handle, Non-Rising Stem
   5. Manufacturer/Model: Nibco T-113K; Apollo 102T-K; or Approved Equal

2.6 QUICK COUPLING VALVES

A. Small Mainline Valve
   1. Size: 1-Inch, normally closed
   2. Construction: Brass, Spring-Loaded Valve Seat, Key Engaged, Brass Swing Joint Assembly off Ductile Iron Service Tee
   3. Ratings: 125 psi
   4. Features: ACME Key with 1-Inch Male ACME and ¾ Female AMCE Top, Vinyl Cover, Add 1-Inch 40 psi Pressure Regulating Valve on Riser from Service Tee
   5. Manufacturer/Model: Hunter HQ-44RC-AW; or Approved Equal. Pressure Regulating Valve: Rain Bird PSI-M40X-100; or Approved Equal

2.7 VALVE BOXES

A. General
   1. Size:
      a. 12-Inch Standard Valve Box
         1) Single 2-Inch Electric Zone Valve
         2) Double 1-Inch or 1½-Inch Electric Zone Valves
      b. 6-Inch Round

1) Wire Splices

c. 10-Inch Round

1) Single 1-Inch or 1½-Inch Electric Zone Valve
2) Isolation Valve
3) Quick Coupling Valve

2. Construction: Resin
3. Ratings: Tensile Strength 3,000-5,000 psi
4. Color: Green or Black (per Owner's Representative)
5. Features: Lockable, Bolt-Down Covers
6. Manufacturer/Model: Carson, Model Specification Grade NDS Pro; Rain Bird VB; or Approved Equal

2.8 ROTOR SPRINKLERS

A. Body

1. Size: 6-Inch Pop-Up with 1-Inch FPT Bottom Inlet
2. Ratings:
3. Construction: Gear-Driven, Removable Nozzle, Internal Check Valve, Stainless Steel Retraction Spring, Rubber Cover, Stainless Steel Riser
4. Features: Adjustable Part and Full Circle
5. Manufacturer/Model: Hunter I-25-06-SS; or Approved Equal

B. Nozzles

1. Size: See Contract Drawings
2. Ratings: 0.36 to 14.8 gpm; 25-70psi
3. Manufacturer/Model: Hunter I-25 Nozzle; or Approved Equal

2.9 EARTH MATERIALS

A. Stone (in Valve Boxes)

1. Type: ¾-Inch (minimum) Crushed Stone

B. Clean Sand

1. Gradation: (passing by weight)
   a. No. 4 Sieve= 80% Minimum
   b. No. 200 Sieve = 5% Maximum

C. Concrete

1. Ratings: 3,000 psi 28-day Compressive Strength
2. Standards: ASTM C-33, ASTM C-94, ASTM-C150

PART 3 - EXECUTION

3.1 GENERAL

A. Competent superintendents and assistants shall be on-site at all times during product delivery, installation, testing, and system adjustments.

1. Field communication by Owner or Owner's Representative to superintendent shall be binding.

B. System features shall be laid out as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Representative before acceptance.

1. Irrigation lines shown on Construction Drawings are diagrammatic only. Location of irrigation equipment is contingent upon and subject to integration with all other underground utilities, tree roots, and hardscape design elements.

3.2 EXAMINATION

A. Review and verify project conditions are as indicated on Construction Drawings prior to starting work, including but not limited to:

1. Utilities provided by Others
2. Site grades and dimensions
3. Landscaping and features
4. Structures
5. Pipe sleeves

B. Report any irregularities of site conditions to the Owner's Representative prior to beginning work.

C. Beginning of installation connotes acceptance of existing project conditions.

3.3 PROJECT COORDINATION

A. Coordinate with Owner's Representative to expeditiously install system.

B. Provide written notifications (electronic is acceptable) to Owner's Representative prior to work commencement, weekly for progress report, for any proposed changes to system design, and upon installation completion.

C. All questions of design intent, proposed design changes, field notifications, and product substitution after installation commences shall be in writing to Owner's Representative as a Request for Information (RFI).

D. Utility Coordination:

1. Maintain 6-inch minimum clearance between irrigation lines and any utility line. Do not install sprinkler lines directly above another utility of any kind.
2. Exercise care when excavating, trenching and working near existing utilities.

3.4 SITE PROTECTION

A. Protect landscaping, paving, structures, walls, footings, etc. from damage caused during work. Damage to work of another trade shall be reported at once.

B. Replace or repair any damage with same product or material, to the satisfaction of Owner's Representative at no additional cost to the Owner per Guarantee.

C. Route pipe as necessary to prevent damage to tree roots. Where trenching must occur near trees, provide proper root pruning and sealing methods to all roots 1-inch and larger.

3.5 EXCAVATION, TRENCHING, AND BACKFILLING

A. Notify and request approval from Owner's Representative if pipe pulling is the intended installation method. Pipe pulling is an accepted installation practice only under the following conditions:
   1. Maximum pipe size 2 inches, and
   2. Suitable soils (i.e. naturally rounded loamy soils without sharp rocks), and
   3. Specified pipe burial depth can be maintained.

B. Pipe Trench:
   1. Excavate trenches straight and true, minimizing site disturbance as possible.
   2. Final trench bottom shall be undisturbed soil and shall be free of rocks and debris larger than 1 inch or with sharp edges. If trench base is unsuitable for laying pipe, over excavate 2 inches below pipe invert, and place Clean Sand or Stone.

C. Clean Backfill:
   1. Material: Clean Sand (See Earth Materials)
      a. Clean backfill must be free of foreign material, debris, frozen material and rocks larger than 1-inch.
   2. Carefully place clean backfill a minimum depth of 10-inches over pipe and wire, tamp in place.
   3. Carefully place material around pipe and wire, tamp in place.

D. Trench Backfill:
   1. Material: Re-use excavated material
      a. Clean backfill must be free of foreign material, debris, frozen material, and rocks larger than 1-inch.
   2. Place and compact in maximum 6-inch lifts to dry density equal to undisturbed soil. Compaction by truck or equipment tires is prohibited.
   3. Avoid backfilling in hot weather.
   4. Match adjacent subsurface grades without hills or depressions. Repair settling (as required by Guarantee).
   5. If final planting soils, mulch, or sod were removed or disturbed during trenching, replace to match Project Specifications and regrade as necessary.
      a. Use sod cutter where applicable, or reseed disturbed areas to acceptance of Owner.

3.6 PIPE INSTALLATION

A. Cut plastic pipe with handsaw or pipe cutter, removing all burrs at cut ends. All pipe cuts shall be square and true. Bevel cut end as required to conform to manufacturer instructions.

B. Make all solvent-weld joints as per manufacturer's instructions and avoid applying excess primer or solvent. Do not wipe off excess solvent from each connection.

1. Allow welded joints minimum 5 minutes set-up/curing time before moving or handling.
    a. Above 80ºF: Allow connections to set 24 hours.
    b. Below 80ºF: Follow manufacturer instructions.
    c. Below 40ºF: Prohibited.

C. Maximum deflection per joint shall not exceed manufacturer limits.

D. Maintain 1-inch minimum between lines which cross at angels of 45 to 90 degrees

E. Pipe and wire shall run in same trench as mainline, at the elevation of the pipe invert (See Wire Installation).

F. Pipe Cover (unpaved surfaces):
    a. PVC Mainline = 22 inches
    b. PVC Lateral = 16 inches

G. Pipe Protection:
1. Prevent foreign material from entering pipe during installation.
2. Open ends of pipe shall be closed by watertight plug or seal when not in use.
3. Securely store pipe when not scheduled for installation.
4. Pipe shall not be installed when water is in trench, during rainstorms, or when temperature is below 40 ºF.
    a. No additional pipe may be installed or backfilled if water enters trench during pipe installation. Remove all water from trench before resuming installation.
    b. Pipe installed at temperatures below 40 ºF shall be removed and replaced at no cost to owner.
5. Trenched PVC pipe shall be snaked to accommodate for expansion and contraction due to changes in temperature.

3.7 PIPE SLEEVE INSTALLATION

A. Coordinate with Owner's Representative for provided pipe sleeves and locations installed by Earthwork Contractor.

B. New Pipe Sleeves:
1. Pipe Sleeve Cover: Minimum 24 inches
2. Install pipe sleeves where irrigation pipe runs under hardscape (see Construction Drawings).
3. Extend pipe sleeves minimum 18 inches beyond edges of hardscapes.
4. Prior to installation of pipe, pipe sleeve ends shall be field marked with vertical wood stakes extending above grade to allow field location during irrigation system installation.

C. Cutting through or jacking under new pavement shall be strictly prohibited. Failure to provide sleeves shall require notification to Owner's Representative for resolution.

3.8 ELECTRICAL CONDUIT INSTALLATION

1. Electrical conduit shall be installed:
   a. Under and through all hardscape areas,
   b. Above ground wiring,
2. Electrical conduit shall extend 18-inches beyond edges of hardscape.

3.9 ELECTRIC ZONE VALVE INSTALLATION

A. Install electric zone valves on level crushed stone base generally where shown on Construction Drawings. Do not pour stone around valves that are already installed.

B. Install all Schedule 80 PVC threaded nipples with Teflon tape, isolation valves, and/or union couplings in and out of electric zone valves as shown on details on Construction Drawings.

C. Set valves plumb with adjusting handle and all bolts, screws, and wiring accessible through valve box opening.

D. Install at sufficient depth to provide between 4-6 inches of cover from top of valve to finish grade.

E. Install specified valve box over all electric zone valves. Ensure lid is flush with final proposed grade (coordinate with Site Contractor).

F. Adjust zone valve operation after installation using flow control device on valve.

3.10 ISOLATION VALVE INSTALLATION

A. Install isolation valves per detail where indicated on Construction Drawings.

B. Install all isolation valves on level crushed stone base for operation ease with appropriate valve wrench. Do not pour stone around valves that are already installed.

C. Install specified valve box over all isolation valves. Ensure lid is flush with final proposed grade (coordinate with Site Contractor).

D. Check and tighten valve bonnet packing before valve box and backfill installation.

3.11 QUICK COUPLING VALVE INSTALLATION

A. Install quick coupling valves where indicated on Construction Drawings; generally, at ends of mainline branches and immediately downstream of well.

B. Mount mainline quick coupling valves on 1-inch diameter, 12-inch long brass swing joint assemblies and stabilizers.

C. Where mainline pressure exceeds 60 psi, install pressure regulating valves to 40 psi off quick coupling valve service tee.

3.12 WIRE INSTALLATION (TWO-WIRE)

A. Install wiring per local codes for less than 30-Volt service.

B. Install valve two-wire in trench alongside mainline at invert elevation. Backfill carefully to avoid any damage to wire insulation on conductors.

1. In areas of unsuitable material, use clean sand in bottom of trench before placing wire (see Excavation, Trenching, and Backfilling)
2. Minimum cover: 12-inches

C. Maintain sufficient slack for expansion, contraction and servicing. Do not install wiring tightly.

1. Provide and install additional 8 to 12 inches slack for conventional wire from decoder to valve.
2. Provide 30 inches slack between decoders for two-wire.
3. Provide sufficient length of wire in valve boxes to allow valve solenoid, splice, decoder wire, and all connections to be brought above grade for servicing.
4. Coil slack for neatness in valve box.

D. Provide waterproof splices at all in-ground wire connections using approved splice kits. All splices shall be made in valve boxes and recorded on Record Drawings.

E. Provide complete wiring diagram showing wire routing for connections between controller and valves as specified in Record Documents.

F. Securely store wire when not scheduled for installation.

3.13 DECODER INSTALLATION

A. Wiring

1. With waterproof splices, connect decoder red wire to site red wire and decoder black wire to site black wire.
2. With waterproof splices, connect decoder valve leads to electric zone valve solenoid leads.
3. Place wired decoder neatly inside valve box.
4. Connect with irrigation controller and run diagnostic decoder search to link.

B. Grounding (Over Earth, Not Over Structures)

1. Provide grounding for decoders with grounding rod and lightning surge arrestor.
2. Grounding shall be provided for every 6 decoders or 500 feet maximum.
3. With waterproof splices, connect lightning arrestor red wire to site red wire and lightning arrestor black wire to site black wire. Decoder, lightning arrestor, and site two-wire may be connected in the same waterproof splice as per manufacturer.
4. With waterproof splice, connect lightning arrestor ground green wire to 8AWG solid bare copper wire. Bury bare copper wire grounding wire 12 inches minimum (or per local code) and run to grounding rod valve box.
5. Place wired lightning arrestor neatly inside valve box.
6. Prepare 6-inch round valve box for grounding rod installation 8 feet from all valve boxes and electrical equipment. Drive 8-foot grounding rod into earth with 6 inches minimum below valve box lid.

7. Make Cadweld connection between bare copper wire from lightning arrestor splice to grounding rod lug.
8. Bolt down grounding rod valve box lid.
9. Where grounding rods cannot be driven into the earth, splice all lightning arrestor green wires in series (with 8AWG green jacketed copper wire) and coordinate acceptable earth grounding with site Electrical Contractor.

3.14 SPRINKLER INSTALLATION

A. Rotor sprinklers shall not exceed maximum spacing as indicated on Construction Drawings.

B. Install rotor sprinklers flush with grade on PVC swing joints as specified.

C. Flush system before installing internals, flush caps, and nozzles (see Testing and Adjustments)

D. Adjust all rotor sprinklers after installation using flow control device on valve.

3.15 AUTOMATIC IRRIGATION CONTROLLER INSTALLATION

A. Controller
1. Install controller at location shown on Construction Drawings.
2. Wire valves and external sensors into controller through conduits and set proper programming.
   a. Program “Cycle-Soak” feature for all zones with excessive slope or poorly draining soils.
3. Using licensed electrical, wire controller to 120-Volt, 20-Amp electrical supply provided by Electrical Contractor.
4. Provide keys to Owner after final walkthrough.

B. Flow Sensor
1. Install Flow Sensor where shown on Construction Drawings.
2. Provide straight pipe for Flow Sensor to reduce turbulence:
   a. Upstream: 20 inches (10 times pipe diameter)
   b. Downstream: 10 inches (5 times pipe diameter)
3. Wire Flow Sensor to Automatic Irrigation Controller as specified with waterproof connectors. Do not use splices between Controller and Flow Sensor.

C. Grounding (Over Earth, Not Over Structures)
1. When required by Electrical Contractor, provide secondary (outdoor) grounding for irrigation controller with grounding rod and grounding plate. Refer to Construction Drawings details for installation steps.
2. Wire bare copper 8AWG wire to irrigation controller ground lug. Run ground wire outdoors to designated area for grounding rod and plate. Cadweld ground wire to additional bare copper 8AWG wire for grounding plate.
3. Grounding Rod

a. Prepare stone base for 4-inch round PVC or ADS drain pipe, 18 inches deep with open drain grate. Ensure no other wire or electrical services are located within 12-foot radius for sphere of influence.

b. Drive 12-foot grounding rod into earth through center of stone base with minimum 6 inches below grate cover.

c. Drill hole through PVC or ADS drain pipe wall 12 inches below grade.

d. Place PVC or ADS drain pipe centered over stone and grounding rod.

e. Feed bare copper grounding wire through drilled hole in drain pipe wall.

f. Make Cadweld connection between bare copper wire and grounding rod.

g. Place open grate on PVC or ADS drain pipe. Regrade and reseed around grate to make flush with existing grade (do not create high or low points at grate). Bolt or screw down grate to drain pipe wall.

4. Grounding Plate

a. Ensure no other wire or electrical services are located within 12 inches from each long side and 8 feet off each end of grounding plate for sphere of influence.

b. Install grounding plate 36 inches below grade. Set grounding plate within 50 pounds of ground enhancement material spread evenly above and below plate.

c. Place 4-inch diameter, 36-inch deep PVC or ADS drain over center of grounding plate. Place open grate on PVC or ADS drain pipe. Regrade and reseed around grate to make flush with existing grade (do not create high or low points at grate). Bolt or screw down grate to drain pipe wall.

5. Where secondary grounding with grounding rods and plates are not required (as confirmed by Electrical Contractor), connect bare copper 8WG wire to controller ground lug and connect to earth ground as directed by Electrical Contractor (example: copper pipe, building ground system). Do not create grounding loop with field decoders (different ground locations outside of influence spheres).

3.16 VALVE BOX INSTALLATION

A. Furnish and install valve boxes as per valve schedule above for each valve, splice, or sensor.

B. Install valve boxes on minimum 4-inches crushed stone base. Pouring stone into valve box after installation is not acceptable.

C. Finish elevation of all boxes shall be at grade, unless otherwise noted in Drawings.

3.17 TESTING AND ADJUSTMENTS

A. Include all testing and adjustments in submitted bid price.

B. System Flushing:

1. Open electric zone valves and flush out irrigation system under full head of water before installing sprinkler internals, flush caps, and nozzles.
2. Flush entire irrigation system after complete installation.
3. Clogged nozzles shall be remedied after completion of irrigation system.

C. Testing:

1. Test all pipe and valves for leaks at operating pressure. Repair all leaks and retest until leaks are remedied.
2. Perform coverage test with Owner's Representative present. Operate electric zone valves for five (5) minutes minimum during coverage test. Readjust sprinkler nozzles and head locations (as necessary) to attain proper coverage. Replace any equipment that does not meet specified standards.
3. After testing, clean all equipment of debris during installation.

D. Adjust sprinkler heads and valve boxes as necessary for mowing and landscaping.

E. Throughout guarantee period, adjust sprinklers and ensure coverage due to settlement and landscaping operations.

3.18 RECORD DOCUMENTS

A. Record (As-Built) Drawings

1. Maintain and update Record Drawings with red-line markings as project progresses, including locations of:
   a. Sprinklers and descriptions (nozzle, pop-up height, and type)
   b. Valve Boxes and descriptions (valve type, zone numbers, splice, etc.)
   c. All equipment installed with distinct symbols.
   d. Pipe routing and tees.
   e. Wire routing and splices.
2. Locations of installed equipment (valve, controller, sensors) shall be referenced by two permanent locations (swing ties) or GPS.
3. Make all notes legible as work progresses, any new equipment added shall use distinct symbols denoting location.
4. Document any changes from original Construction Drawings.
5. Prints of original Construction Drawings may be obtained from the Owner's Representative at cost (0% markup).
6. Record Drawings shall be used as basis of payment for work completed. Provide copies of red-lined set to Owner's Representative along with payment request.

B. Record Documents

1. Record Documents shall be on-site at all times. Maintain record of the following as the project progresses:
   a. Plumbing and Electrical permits (state whether or not required)
   b. Materials Approved and approval date
   c. Pressure Test results, testing personnel and testing date.
   d. Materials delivered, Accepted, and Installed by whom and date.
   e. Field Communications and Requests for Information (RFI)

C. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings and Documents to Owner's Representative as part of project completion. All information must be complete and shall be added to submitted documents prior to acceptance.

3.19 OPERATION AND MAINTENANCE

A. General

1. Bid price shall include up to four (4) hours of irrigation system overview and instruction with Owner and/or Owner's Representative.

B. Operation and Maintenance Manual

1. Provide three (3) hard cover binders titled "Operation and Maintenance for Beverly Middle School Athletic Field Irrigation System" prior to application for acceptance and final payment.
2. Operation and Maintenance Manual shall include, but not be limited to:
   a. Title Page and Table of Contents
   b. One-Paragraph Written Description of Irrigation System
   c. Manufacturers' Data and Cut Sheets of Equipment, including:
      1) Copies of all approved submittals
      2) Wire resistance readings to each electric valve at completion (for future troubleshooting)
      3) Recommended operating settings
      4) Recommended maintenance schedule
      5) Name, address, and telephone number of installer (for repairs, spring startup, and winterization during 1-year guarantee period)
      6) Irrigation program for periods without rain and recommended settings including, zone run time, days per week, cycle-soak, and rain sensor suspension.
   d. Winterization and Spring Startup Instructions (after 1-year guarantee period)
   e. Guarantee Data
   f. Pockets with Folded Plans of:
      1) Original Design Drawing
      2) Final Record Drawing
      3) Controller Valve and Wiring System Diagram Drawing

3.20 SITE CLEANUP

A. Remove all unused materials and equipment from project site safely and efficiently. Dispose of all unused materials legally - including construction debris and trash.

B. Adjust ground, compact, and re-plant around irrigation sprinkler heads and trenches as necessary for proper angle and elevation.

C. Fill all depressions, erosion rills, tire tracks, etc. with proper planting soil mix to ensure site drainage.

3.21 FINAL OWNER ACCEPTANCE

A. Final Owner Acceptance of Irrigation System is predicated on:

1. Complete system installation, adjustment, testing, and instructional overview.
2. Submission of Operation and Maintenance Manuals to Owner's Representative.
3. Proper Programming of Automatic Irrigation Controller.

4. Completed and approved all punchlist items.

B. Owner and/or Owner's Representative shall provide written notice (hard copy and/or electronic) for Final Acceptance. Date of Final Acceptance notice shall serve as start of 1-year Guarantee period as described above.

End of Section

Section 32 92 00

SOIL PREPARATION FOR LAWN ESTABLISHMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Loam from off-site, if on-site is insufficient
2. Loam Testing
3. Grading and Spreading Loam
4. Preparations of Seed Beds
5. Application of Soil Additives
6. Application of Turf Maintenance Fertilizer
7. Applying Jute Mesh

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years' experience on similar projects.

B. Contractor shall not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

C. All fertilizer applications shall be performed by a licensed applicator in strict conformance with all local, state and federal regulations. Contractor shall notify the Owner's Project Representative at least two weeks prior to scheduled application. A copy of the applicator's license shall be given to the Owner's Representative.

D. Pre-Construction Meeting – Contractor shall request in writing an on-site meeting with the Owner's Representative, the General Contractor and Site Contractor and the Landscape Architect and the Civil Engineer to review the scope of work prior to any work taking place to review the subgrade conditions. Any deficiencies in the subgrade conditions shall be remedied by the contractor and approved by the Owner prior to any loam being spread.

E. Any loam stockpiles sitting beyond one growing season shall be covered. Contractor shall be responsible for complete removal and disposal of any weed seed established on loam stockpiles prior to placement and spreading of loam.

F. The materials shall not be handled or moved when in wet or frozen conditions.

1.4 SUBMITTALS

A. Samples shall be as follows:

1. The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing loam for testing. All stockpile sampling shall be per ASTM D 75 and Appendices.
2. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size type plastic bag and close. Label each sample on outside of bag, identifying sample by soil type and stockpile location and phase of construction.
3. Loam from off-site, if on-site loam is insufficient: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

B. Contractor shall submit to the Owner's Representative samples, manufacturer's product data, and source of off-site loam and certified testing of off-site loam at least 60 days prior to delivering material on site.

C. Contractor shall submit to the Owner's Representative samples and certified test results for on-site loam 60 days prior to using material to allow for reformulation and retesting if test results are rejected.

D. Contractor shall submit to the Owner's Representative certified test results for loam with added amendments 60 days prior to using material to allow for reformulation and retesting if test results are rejected.

E. Testing: Testing shall be as follows:

1. General
    a. On-site stockpiled loam shall be tested at the beginning of each phase of construction prior to its use in its respective phase.
    b. Contractor shall provide current certified test results for off-site, imported loam to be used on the project prior to use. Testing date shall be within the current year the loam is to be used on the project.
    c. Contractor shall provide current certified test results of all soil amendments including organic compost and soil additives prior to use.

d. All testing and re-testing shall be at the expense of the Contractor. Contractor shall deliver samples to an independent testing facility such as the University of Mass Experiment Station and have the results forwarded to the Owner's Representative for review and approval prior to using the material.

e. Samples for tests shall be taken from on-site stockpiles in the presence of the Owner's Representative.

2. Testing reports shall include the following tests and recommendations:

a. Percent organic matter by weight as determined by the loss on ignition of samples that have been oven dried to a constant weight at temperature of 105 degrees C.

b. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.

c. Chemical Analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Lead, Zinc, Soluble Salts, extractable Aluminum, Cadmium, Copper, pH and buffer pH, carbon:nitrogen ratio and toxic elements. Except where otherwise noted, nutrient tests shall be for available nutrients.

d. Soil analysis tests shall show recommendations for soil additives to correct soils to meet the specifications and for additives necessary to accomplish lawn and planting work as specified.

e. Certified analysis, manufacturer, labels and source of organic compost and soil additives to be provided.

1.5 DEFINITIONS

A. The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.6 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable sandy loam with no admixture of refuse or any natural or introduced materials toxic to plant growth and free of subsoil, refuse, stumps, roots, rocks, cobbles, stones, brush, clay lumps, noxious weeds, litter and other deleterious materials. Loam shall not come from USDA-classified prime farmland.

B. Loam shall be one of the following sandy loams: “coarse sandy loam”, “sandy loam”, “fine sandy loam” based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

		Percent Passing By Weight	
Millimeter	US Sieve Size	Max.	Min.
4	#5	100	95
2	#10	95	90
0.42	#40	90	60
0.149	#100	60	30
0.074	#200	30	20
0.037	#400	20	0

1. One hundred percent shall pass a half inch sieve opening, and the maximum retained on the quarter inch sieve shall be 20 percent by weight of the total sample.
2. On-site and off-site loam shall be screened to achieve the above specified sieve analysis.
3. Organic matter in approved planting soil shall be between 5% minimum and 8% maximum by weight as determined by the loss on ignition of samples that have been oven dried to a constant weight at temperature of 105 degrees C.
4. Acidity range of planting soil shall be 5.5 to 6.5 pH when tested according to methods of testing or A.O.A.C.
    a. When pH of loam borrow is equal to or greater than the maximum use aluminum sulfate to adjust pH to required levels.
    b. When pH of loam borrow is less than the minimum required use either sulfur or ferrous sulfate to adjust pH to required levels.

C. Soluble salt content shall be less than 100 PPM.

D. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

2.2 ORGANIC COMPOST

A. Organic Compost shall be natural or manufactured mature, composted organic material produced from a DEP-approved composting vendor. Only Federal EPA Class A or Massachusetts Type I compost products shall be used. The following shall be requirements shall be met:

1. Compost shall originate from mature leaf compost, mature composted animal manure, other aged, composted vegetable materials such as brewer's waste, or chemically tested toxin-free processed sludge products (biosolids).
2. Test results shall indicate maturity and age of organic compost. Raw uncomposted or unprocessed or incompletely composted organic matter shall be rejected.
3. Organic matter manufactured from sludge and other biowaste materials or manure, shall be aged for at least one (1) year without exception and shall have no biowaste odor.
4. Compost shall contain no uncomposted bulking agents such as uncomposted wood chips and shall be free from hard lumps and free from seeping water when handled.
5. Compost shall be free from sticks, stones, plastic, debris or other substances which would be injurious to healthy plant growth. 100% of compost material shall pass a ½" sieve.
6. Acidity range shall be pH 6 minimum and 8 maximum when tested according to methods of testing or A.O.A.C.
7. Organic matter shall not be less than 30% as determined by ASTM D2974.
8. Moisture content of 35% to 70%, as determined by ASTM D2974
9. Carbon:Nitrogen ratio of 15:1 to 30:1
10. Solvita intex of 6 to 8
11. Non-phytotoxic
12. There shall be no unpleasant or detectable odor of ammonia or hydrogen sulfide, which would indicate immature compost. Color of compost shall be dark brown.

2.3 SOIL ADDITIVES

A. Limestone for adjustment of soil pH shall be agricultural grade ground dolomitic limestone containing up to 50% magnesium carbonate in a dry, granular form. Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 90% to 100% will pass through a 20-mesh sieve.

B. Aluminum Sulfate for adjustment of soil pH shall be commercial sulfur, unadulterated, 57% and delivered in containers with the name of the manufacturer, material analysis and net weight appearing on each container.

C. Lawn Starter and Maintenance Fertilizer:

1. Fertilizer shall be a complete commercial product complying with the State and Federal fertilizer laws. Fertilizer shall be pelletized. Deliver to the site in the original unopened containers that shall bear the manufacturer's certificate of compliance covering analysis. At least 50% by weight of the nitrogen content shall be derived from organic materials. Fertilizer shall contain not less than the percentages of weight of ingredients as follows or as recommended by the soil analysis:

   Nitrogen 10%

Phosphorus 6%
Potash 4%

2. Adjust nitrogen type and analysis for spring growth and slow release in fall.
3. Application Rate: Per manufacturer's instructions and as recommended by soil test results.

D. Sand: Shall be clean, course, angular, ungraded material meeting ASTM C33 with the following addendums:
1. Sand shall not be gravelly
2. Sand shall not be beach sand
3. Sand shall have a fineness modulus of 2.5 to 3.2
4. A coefficient of uniformity (D60/D10) of less than 4

E. Bone Meal: shall be fine ground, steam cooked, packing house bone with a minimum analysis of 23% phosphoric acid and 4% nitrogen.

F. Gypsum: shall be agricultural grade, granular form. Gradation shall conform to the following:

Sieve Designation	Percent Passing By Weight
No. 8 (2.36mm)	100
No. 16 (1.18mm)	97
No. 30 (0.60mm)	82
No. 50 (0.30mm)	46
No. 100(0.15mm)	21

G. Jute Mesh: Jute mesh shall be uniform, open, plain weave of undyed and unbleached single jute yarn, a minimum of four (4) feet in width plus or minus one (1) inch. There shall be 78 warp ends per width and 41 weft ends per yard. Weight shall average 1.22 pounds per linear yard, plus or minus 5%. Staples for Erosion Control Materials: 9 gauge staples shall be used with jute mesh: 11 gauge with woven paper.

2.4 WATER

A. Clean, fresh potable water free of salt and other impurities injurious to vegetation.

PART 3 - EXECUTION

3.0 MIXING, GRADING AND SPREADING AMENDED LOAM

A. Contractor shall amend loam with organic compost and soil additives to meet requirements in these specifications and only after approval of test results shall amended loam be spread.

B. Prior to any spreading of loam, it is the responsibility of the Contractor to request a meeting with the Owner's Representative and the Landscape Architect to review and approve the subgrade condition. Subgrade shall meet

the requirements outlined in Section 31 00 00 – Earthwork.

C. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials.

D. **Loam shall be spread as required on all disturbed and bare areas to produce a total depth of six (6) inches as shown on the plan.** Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00-Earthwork prior to spreading loam, then shape and finish grade to depth of loam required.

E. Area shall be progressively fine graded and machine and hand raked, with loam added as required to correct depressions and other irregularities, to produce smooth and unbroken finish grades and the depth of loam required.

F. Finish grades shall conform to lines, grades, sections, and shapes of lawn areas as required to meet design intent on Plans. Provide positive drainage. Provide smooth, uniform, rounded transitions at all changes and break in grade. Loam is to be consistent depth of 1/2" below adjacent pavements surfaces.

G. Starter fertilizers: All required materials shall be spread and distributed into the soil at rates and amounts specified herein.

H. After establishment of finish grade, entire area shall be hand or machine raked and rolled using a light roller.

3.1 PREPARATION OF AREAS FOR SEEDING

A. GENERAL DESCRIPTION: This work shall consist of the preparation of the seed bed. Work shall be done as described herein:

1. Areas shall be finely raked to a finished grade. Material ½” or greater in any dimension shall be removed and disposed of per the contract specifications.
2. Where the soil has become compacted, prior to fine raking, areas to be seeded shall be scarified by discing, york raking, or other approved method to a minimum depth of two (2) inches.
3. Where the soil is loose and soft, prior to fine raking, areas to be seeded shall be lightly rolled and soil added as required to meet finished grades.
4. No seeding will be permitted on areas where the seed bed has not been prepared per the specification.
5. Any debris that falls on paved or other hardscape areas shall be removed by the Contractor.
6. **Prior to any seeding operations, it is the responsibility of the Contractor to request in writing a meeting with the Owner’s Representative and the Landscape Architect to review and approve the seed bed and proposed method of seed application. Refer to Section 32 92 20 and Section 32 92 40.**

3.2 APPLICATION OF LIMESTONE

A. When applied dry, limestone shall be spread evenly and incorporated thoroughly into the soil by discing or other approved means.

B. When applied hydraulically, no discing will be necessary.

C. Granular treatment to be applied at the rate required by soil pH test to produce a pH required per this specification.

3.3 APPLICATION OF STARTER AND MAINTENANCE FERTILIZER

A. One application of turf maintenance fertilizer will be required before final acceptance of seeded areas.

B. Application Rate: Refer to Section 2 in this specification.

C. Contractor shall notify the Owner's Project Representative at least two weeks prior to scheduled application. Contractor shall obtain approval in writing by the Owner's representative.

3.4 APPLYING JUTE MESH

A. Jute mesh shall be applied to any slopes 4:1 or steeper.

B. Apply jute mesh loosely but smoothly to fit the contour of the finished grade, parallel to and in same direction as the flow of water. The up-slope end of the each separate strip or piece of jute mesh shall be buried in a six (6) inch minimum vertical anchor slot of junction slot with the soil tamped firmly against the mesh. Where more than one width of material is required, edges shall overlap a minimum of twelve (12) inches, and the up-slope section of mesh will be on top. Down-hill ends of the jute mesh shall be folded under approximately four (4) inches and stapled in place. Staples will be inserted through the mesh along edges, overlaps, and in the center of all jute mesh strips at intervals not greater than three (3) feet. All anchor slots, junction slots, check slots, and terminal folds shall have five (5) staples spaced not more than nine (9) inches on center across widths.

C. On seeded banks, jute shall be applied immediately after seeding.

END OF SECTION

Section 32 92 10

SOIL PREPARATION FOR ATHLETIC FIELDS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Loam from off-site, if on-site is insufficient
2. Testing
3. Grading and Spreading Loam
4. Preparations of Seed Beds
5. Application of Soil Additives
6. Application of Turf Maintenance Fertilizer

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
4. Section 31 00 00 - Earthwork
5. Section 31 11 00 – Site Preparation
6. Section 32 92 30 – Sodding

1.3 MINIMUM REQUIREMENTS

A. The successful bidder shall meet the following minimum requirements in order to be considered for installation of the athletic fields. **All requirements listed in 1.3 MINIMUM REQUIREMENTS shall be documented and submitted to the Architect for approval prior to commencement of any athletic field work.**

1. Selected installer must have installed fields greater than three (3) years old of

similar materials and design. **Documentation of this shall be furnished per 1.3, A above.**

2. Selected installer must install athletic fields using his/her own crews, subcontracting of installation work will not be allowed.
3. Selected installer must have a minimum of five (5) outdoor fields at over 50,000 square feet each installed in the Northeast United States of similar construction. **A list of these installations with owner's name and phone number shall be furnished per 1.3, A above.**
4. Selected installer must have a minimum of five (5) years' experience in the installation of athletic fields. The crew foreman shall have installed a minimum of five (5) similar installations. **A list of previous projects installed by foreman shall be furnished per 1.3, A above.**

1.4 QUALITY ASSURANCE

A. The approved installer shall meet with the Site Contractor and General Contractor to review the following:
   1. Review the entire system including subgrade, base, utilities, and drainage to ensure all components are complimentary.
   2. Installation of the athletic field shall be done only after excavation and construction work which might injure it has been complete. Damage caused during construction shall be repaired prior to acceptance.

B. Contractor shall not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

C. All fertilizer applications shall be performed by a licensed applicator in strict conformance with all local, state and federal regulations. Contractor shall notify the Owner's Project Representative at least two weeks prior to scheduled application. A copy of the applicator's license shall be given to the Owner's Representative.

D. Pre-Construction Meeting – Contractor shall request in writing an on-site meeting with the Owner's Representative, the General Contractor and Site Contractor and the Landscape Architect and the Civil Engineer to review the scope of work prior to any work taking place to review the subgrade conditions. Any deficiencies in the subgrade conditions shall be remedied by the contractor and approved by the Owner prior to any loam being spread.

E. Any loam stockpiles sitting beyond one growing season shall be covered. Contractor shall be responsible for complete removal and disposal of any weed seed established on loam stockpiles prior to placement and spreading of loam.

F. The materials shall not be handled or moved when in wet or frozen conditions.

1.5 SUBMITTALS

A. Samples shall be as follows:
   1. The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing loam for testing. All stockpile sampling shall be per ASTM D 75 and Appendices.

2. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size type plastic bag and close. Label each sample on outside of bag, identifying sample by soil type, stockpile location and phase of construction.
3. Loam from off-site, if on-site loam is insufficient: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

B. Contractor shall submit to the Owner's Representative samples, manufacturer's product data, source of off-site loam and certified testing of off-site loam at least 60 days prior to delivering material on site.

C. Contractor shall submit to the Owner's Representative samples and certified test results for on-site loam 60 days prior to using material to allow for reformulation and retesting if test results are rejected.

D. Contractor shall submit to the Owner's Representative certified test results for loam with added amendments 60 days prior to using material to allow for reformulation and retesting if test results are rejected.

E. Testing: Testing shall be as follows:
1. General
   a. On-site stockpiled loam shall be tested at the beginning of each phase of construction prior to its use in its respective phase.
   b. Contractor shall provide current certified test results for off-site, imported loam to be used on the project prior to use. Testing date shall be within the current year the loam is to be used on the project.
   c. Contractor shall provide current certified test results of all soil amendments including organic compost and soil additives prior to use.
   d. All testing and re-testing shall be at the expense of the Contractor. Contractor shall deliver samples to an independent testing facility such as the University of Mass Experiment Station and have the results forwarded to the Owner's Representative for review and approval prior to using the material.
   e. Samples for tests shall be taken from on-site stockpiles in the presence of the Owner's Representative.
2. Testing reports shall include the following tests and recommendations:
   a. Percent organic matter by weight as determined by the loss on ignition of samples that have been oven dried to a constant weight at temperature of 105 degrees C.
   b. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.
   c. Chemical Analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Lead, Zinc, Soluble Salts, extractable Aluminum, Cadmium, Copper, pH and buffer pH, carbon:nitrogen ratio and toxic elements. Except where otherwise

noted, nutrient tests shall be for available nutrients.

d. Soil analysis tests shall show recommendations for soil additives to correct soils to meet the specifications and for additives necessary to accomplish lawn and planting work as specified.

e. Certified analysis, manufacturer, labels and source of organic compost and soil additives to be provided.

1.6 DEFINITIONS

A. The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.7 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 – PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable sandy loam with no admixture of refuse or any natural or introduced materials toxic to plant growth and free of subsoil, refuse, stumps, roots, rocks, cobbles, stones, brush, clay lumps, noxious weeds, litter and other deleterious materials. Loam shall not come from USDA-classified prime farmland.

B. Loam shall be one of the following sandy loams: “coarse sandy loam”, “sandy loam”, “fine sandy loam” based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

Sand (0.05 to 2.0 mm) 65% - 75% with no less than 70% of the sand in the medium through very coarse sand fractions (0.25 – 2 mm)

Silt (0.002 to 0.05 mm) 15%-25%

Clay (< 0.002) 10%-20%

Gravel (> 2.0 mm) <15%

Maximum size shall be three eighths (3/8") inches largest diameter.

1. On-site and off-site loam shall be screened to achieve the above specified sieve analysis.
2. Organic matter in approved planting soil shall be between 3% minimum and 6% maximum by weight as determined by the loss on ignition of samples that have been oven dried to a constant weight at temperature of 105 degrees C.
3. Acidity range of planting soil shall be 6 to 7.5 pH when tested according to methods of testing or A.O.A.C.
    a. When pH of loam borrow is equal to or greater than the maximum use aluminum sulfate to adjust pH to required levels.
    b. When pH of loam borrow is less than the minimum required use either sulfur or ferrous sulfate to adjust pH to required levels.

C. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

D. Loam shall yield a saturated hydraulic conductivity value of 1 to 2 inches per hour.

E. It should be noted that the on-site materials will not likely meet requirements of clean screened loam for use within athletic fields specified herein. Contractor shall include imported screened loam for all athletic fields within the Base Bid.

2.2 ORGANIC COMPOST

A. Organic Compost shall be natural or manufactured mature, composted organic material produced from a DEP-approved composting vendor. Only Federal EPA Class A or Massachusetts Type I compost products shall be used. The following shall be requirements shall be met:

1. Compost shall originate from mature leaf compost, mature composted animal manure, other aged, composted vegetable materials such as brewer's waste, or chemically tested toxin-free processed sludge products (biosolids).
2. Test results shall indicate maturity and age of organic compost. Raw uncomposted or unprocessed or incompletely composted organic matter shall be rejected.
3. Organic matter manufactured from sludge and other biowaste materials or manure, shall be aged for at least one (1) year without exception and shall have no biowaste odor.
4. Compost shall contain no uncomposted bulking agents such as uncomposted wood chips and shall be free from hard lumps and free from seeping water when handled.
5. Compost shall be free from sticks, stones, plastic, debris or other substances which would be injurious to healthy plant growth. 100% of compost material shall pass a ½" sieve.
6. Acidity range shall be pH 6 minimum and 8 maximum when tested according to methods of testing or A.O.A.C.
7. Organic matter shall not be less than 30% as determined by ASTM D2974.
8. Moisture content of 35% to 70%, as determined by ASTM D2974

9. Carbon:Nitrogen ratio of 15:1 to 30:1
10. Solvita intex of 6 to 8
11. Non-phytotoxic
12. There shall be no unpleasant or detectable odor of ammonia or hydrogen sulfide, which would indicate immature compost. Color of compost shall be dark brown.

2.3 SOIL ADDITIVES

A. Limestone for adjustment of soil pH shall be agricultural grade ground dolomitic limestone containing up to 50% magnesium carbonate in a dry, granular form. Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 90% to 100% will pass through a 20-mesh sieve.

B. Aluminum Sulfate for adjustment of soil pH shall be commercial sulfur, unadulterated, 57% and shall be delivered in containers with the name of the manufacturer, material analysis and net weight appearing on each container.

C. Lawn Starter and Maintenance Fertilizer:

1. Fertilizer shall be a complete commercial product complying with the State and Federal fertilizer laws. Fertilizer shall be pelletized. Deliver to the site in the original unopened containers that shall bear the manufacturer's certificate of compliance covering analysis. At least 50% by weight of the nitrogen content shall be derived from organic materials. Fertilizer shall contain not less than the percentages of weight of ingredients as follows or as recommended by the soil analysis:

Nitrogen	10%
Phosphorus	6%
Potash	4%

2. Adjust nitrogen type and analysis for spring growth and slow release in fall.
3. Application Rate: Per manufacturer's instructions and as recommended by soil test results.

D. Sand: Shall be clean, course, angular, ungraded material meeting ASTM C33 with the following addendums:

1. Sand shall not be gravelly
2. Sand shall not be beach sand
3. Sand shall have a fineness modulus of 2.5 to 3.2
4. A coefficient of uniformity (D60/D10) of less than 4

E. Bone Meal: shall be fine ground, steam cooked, packing house bone with a minimum analysis of 23% phosphoric acid and 4% nitrogen.

F. Gypsum: shall be agricultural grade, granular form. Gradation shall conform to the following:

Sieve Designation	Percent Passing By Weight
No. 8 (2.36mm)	100

No. 16 (1.18mm)	97
No. 30 (0.60mm)	82
No. 50 (0.30mm)	46
No. 100(0.15mm)	21

2.4 WATER

A. Clean, fresh potable water free of salt and other impurities injurious to vegetation.

PART 3 - EXECUTION

3.0 MIXING, GRADING AND SPREADING AMENDED LOAM

A. Contractor shall amend loam with organic compost and soil additives to meet requirements in these specifications and only after approval of test results shall amended loam be spread.

B. Prior to any spreading of loam, it is the responsibility of the Contractor to request a meeting with the Owner's Representative and the Landscape Architect to review and approve the subgrade condition. Subgrade shall meet the requirements outlined in Section 31 00 00 – Earthwork.

C. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials.

D. Loam shall be spread as specified on all disturbed and bare areas to produce a total depth of six (6) inches as shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading loam, then shape and finish grade to depth of loam required.

E. Area shall be progressively fine graded and machine and hand raked, with loam added to correct depressions and other irregularities, to produce smooth and unbroken finish grades and the depth of loam required.

F. Drawings show grading design intent to achieve a uniform grade not less than 1.25% slope. Finish grades shall conform to lines, grades, sections, and shapes of lawn areas as shown on the plans. Provide positive drainage. Provide smooth, uniform, rounded transitions at all changes and break in grade. Loam is to be consistent depth of 1/2" below adjacent pavements surfaces.

G. Starter fertilizers: All required materials shall be spread and distributed into the soil at rates and amounts specified herein.

H. After establishment of finish grade, entire area shall be hand raked and rolled using a light roller.

3.1 PREPARATION OF AREAS FOR SEEDING

A. GENERAL DESCRIPTION: This work shall consist of the preparation of the seed bed. Work shall be done as described herein:

1. Areas shall be finely raked to a finished grade. Material ½" or greater in any

dimension shall be removed and disposed of per the contract specifications.

2. Where the soil has become compacted, prior to fine raking, areas to be seeded shall be scarified by discing, york raking, or other approved method to a minimum depth of two (2) inches.
3. Where the soil is loose and soft, prior to fine raking, areas to be seeded shall be lightly rolled and soil added as required to meet finished grades.
4. No seeding will be permitted on areas where the seed bed has not been prepared per the specification.
5. Any debris that falls on paved or other hardscape areas shall be removed by the Contractor.
6. **Prior to any seeding operations, it is the responsibility of the Contractor to request in writing a meeting with the Owner's Representative and the Landscape Architect to review and approve the seed bed and proposed method of seed application. Refer to Section 32 92 20.**

3.2 APPLICATION OF LIMESTONE

A. When applied dry, limestone shall be spread evenly and incorporated thoroughly into the soil by discing or other approved means.

B. When applied hydraulically, no discing will be necessary.

C. Granular treatment to be applied at the rate as required by soil pH test to produce a pH required per this specification.

3.3 APPLICATION OF STARTER AND MAINTENANCE FERTILIZER

A. One application of turf maintenance fertilizer will be required before final acceptance of seeded areas.

B. Application Rate: Refer to Section 2 in this specification.

C. Contractor shall notify the Owner's Project Representative at least two weeks prior to scheduled application. Contractor shall obtain approval in writing by the Owner's representative.

END OF SECTION

Section 32 92 20

SEEDING FOR LAWN AREAS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment, and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Application of seed
2. Application of weed control
3. Maintenance of seeded areas
4. Acceptance of seeding

C. In general, seeded areas shall, at a minimum, include all areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans. Overseeding of established lawn areas, if required on plans, shall also extend to the limit of disturbance (LOD), unless otherwise noted.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 32 92 00 - Soil Preparation for Lawn Establishment
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 QUALITY ASSURANCE

A. Subcontract seeding work to a firm specializing in such work unless Contractor is fully experienced and qualified.

B. Each seed bag or container shall display a label which identifies the contents as a true representation of the seed mix and percentages required by specification. No seed shall be applied to a site until display labels are submitted to the Owner's representative and has determined the mixture meets all requirements.

C. Do not make substitutions without written approval. If specified seed mixes are not available, obtain approval for substitution from the Owner's representative.

1.4 SUBMITTALS

A. Certifications and/or labels of proposed seed mixtures stating common and scientific names of grasses, percentages by weight, and percentages of purity and germination.

B. Product information for all proposed weed control chemicals.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Seed mixes which have been damaged or have deteriorated in transit or storage are not acceptable.

C. Seeding Schedule: Prepare a proposed seeding schedule. Schedule dates for each type of landscape work during normal seasons for such work.

Seeding: March 15 - June 30
August 15 - October 15

D. Correlate with specified maintenance periods to provide maintenance to date of acceptance. Once the schedule is accepted, dates shall be revised and submitted in writing for reasons of delay.

1.6 WARRANTY

A. Warranty seeding until final acceptance of grass stand. Final acceptance is defined in Part 3 of this specification.

1.7 MAINTENANCE

A. Maintenance of seeding to be performed by the installer to ensure plant survival and to eliminate undesirable species includes:

1. Watering
2. Mowing
3. Regrading and replanting eroded areas
4. Seeding or patching sparse or bare areas
5. Debris removal
6. Replacement of damaged or dead material
7. Additional fertilizations
8. Additional weed control

B. Maintain seeded areas immediately after placement until seed areas are accepted as outlined in Part 3 of this specification.

PART 2 - PRODUCTS

2.1 MULCH

A. Hydro mulch: Shall be a Bonded Fiber Matrix Hydraulically applied erosion system, consisting of long strand, virgin wood fibers (90% by weight), bound together by a pre-blended, high-strength polysaccharide polymer adhesive (10% by weight). The virgin wood fibers shall be thermo-mechanically defibrated from clean whole wood chips, containing a minimum of 25% of the fibers averaging 10 mm long, with a minimum of 50% or more retained on a #24 mesh screen. The organic binders

shall be a high viscosity. Fiber shall not be produced from recycled material such as sawdust, paper or cardboard.

The bonded fiber matric shall be of such character that it will disperse uniformly into a slurry when mixed with water. The slurry, when hydraulically applied to the ground, shall form an absorptive mat of mulch. No materials which inhibit growth or germination shall be present in the mixture.

2.2 SEED

A. General: Pure, live, fresh seed from commercial sources meeting and labeled in accordance with State and Federal laws, rules and regulations. All seed to have minimum germination rate of 90%.

1. Seed mix for all **general lawn areas** shall conform to the following grass types and percentages:

Improved Perennial Rye	25%
Improved Annual	25%
Creeping Red Fescue	25%
Turf Type Tall Fescue	18.5%
Kentucky Bluegrass 98/85	5%
Red Top	1%
Colonial Bentgrass	0.5%

Sowing Rate: 5 to 7 pounds per 1,000 sq. ft.

Overseed Sowing Rate: 2 to 3 pounds for 1,000 sq. ft.

2. Seed mix for **athletic fields** shall conform to the following grass types and percentages:

Improved Perennial Rye	30%
Improved Kentucky Bluegrass CGT	25%
Improved Kentucky Bluegrass CBT	25%
Chewing Fescue	20%

Sowing Rate: 4 to 6 pounds per 1,000 sq.ft.

Overseed Sowing Rate: 2 to 3 pounds for 1,000 sq. ft.

2.3 WEED CONTROL

A. Pre-emergent weed control for Loam and Seed Areas shall be Treflan 5-G or approved equal. Deliver in manufacturer's fully identified containers and apply according to manufacturer's directions.

2.4 WATER

A. Clean, fresh potable water free of salt and other impurities injurious to vegetation.

PART 3 - EXECUTION

3.1 GENERAL

A. Seeded areas shall, at a minimum, include all areas of site within project limit lines

that have been disturbed or are barren unless otherwise noted on the plans.

B. Temporary stabilization of seeded areas shall be completed by the contractor.

C. Any seeded areas that are rutted or eroded due to construction, weather or otherwise damaged shall be the responsibility of the contractor to correct.

D. Multi-phased projects may have different seeding times based on each phase. It is the contractor's responsibility to follow the specifications herein for each phase of construction.

3.2 APPLICATION OF SEED

A. Seeding operations shall not occur until the seed bed has been approved per Specification 32 92 00, Section 3.1

B. The approved seed mixture shall be applied at a rate indicated in Section 2.2 of this specification by means of a seeder device capable of penetrating ground to depth of 1". Seeder machine shall be equipped with disc-type penetrating action and seeder tubes which plant seeds. Seeder shall be similar to Jacobson Model 524-100, 548100 or equal.

C. Distribute seed over area in two separate passes, each one perpendicular to the other (north-south, east-west orientation). Each pass shall be in a linear progression, and shall conform to the field direction that permits the longest straight line application procedure.

D. Hydro mulch shall be applied to seeded areas after seeding has occurred on athletic fields.

E. Hydroseeding will be permitted only with permission of Owner's Representative. All requests shall be in writing with detailed and itemized procedure to be followed. **Hydroseeding of athletic fields shall not be permitted.**

F. Broadcast seeding will be permitted only with permission of Owner's Representative. All requests shall be in writing with detailed and itemized procedure to be followed.

3.3 APPLICATION OF FERTILIZER

A. Complete fertilizer in granular form shall be applied per Specification 32 92 00 – Soil Preparation for Lawn Establishment and Specification 32 92 10 – Soil Preparation for Athletic Fields.

3.4 ACCEPTANCE OF SEEDING FOR GENERAL LAWN AREAS

A. PROVISIONAL ACCEPTANCE

Provisional acceptance shall be considered after a minimum of **ONE** full growing season as indicated in Section 1.5 Paragraph C. In order for provisional acceptance to be granted, the Contractor shall request in writing to the Owner's Representative that he/she is ready to have the seeded areas reviewed. The following requirements shall be met.

1. Provisional acceptance will not occur until after one full growing season. The seeded areas must be well established, exhibiting a vigorous growing condition and devoid of bare spots greater than 1 square foot.
2. It will be the contractor's responsibility to maintain seeded areas from the time of

seed installation until the date of Final Acceptance. See Section 3.4, C. herein for maintenance requirements.

3. Provisional acceptance will not be granted until contractor has obtained, in writing, a statement from the landscape architect indicating that grass is satisfactory under the terms of the provisional acceptance.
4. Following are some examples of delays in provisional acceptance of seeded areas:
   a. Improper grading:
      -Low or high spots on flat or fairly level areas
      -Improper drainage
      -Washed out or rilled areas
      -Exposed debris
   b. Turf Grass Conditions
      -Poor or thin stands of lawn
      -Improper fertilization application
      -Persistent weeds established in turf areas
      -Significant stands of clover are not considered persistent weeds in general lawn areas

B. FINAL ACCEPTANCE FOR GENERAL LAWN AREAS

In order for final acceptance to be granted, the Contractor shall request in writing to the Owner's Representative that he/she is ready to have the seeded areas reviewed and the following requirements shall be met.

1. All seeded areas have been maintained by the Contractor for not less than one growing season from the time provisional acceptance is granted. Growing season shall be defined as follows:
   a. If provisional acceptance is received during April, May, June or July, next growing season shall end on October 15.
   b. If provisional acceptance is received during September, October, November or December, next growing season shall end on June 1.
2. Inspection will be made by the Owner's Representative and the Landscape Architect. Grass areas not demonstrating satisfactory stands as outlined above, (except if damaged by vandalism) as determined, by the L.A. shall be renovated, re-seeded, and maintained meeting all requirements as specified herein. Maintenance period shall extend to the end of the next growing season, see Section 3.4, B,1 herein.
3. After all necessary corrective work has been completed, the Landscape Architect will submit in writing recommending to the Owner's Representative that Final Acceptance shall be granted.
4. Decision of Owner's Representative as to the necessity to replace grass areas or repair any defects in workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be the same as specified. All replacements shall be planted as specified herein at Contractor's expense.
5. "Vandalism", as noted above, is intended to mean any acts, whether intentional or accidental, by other persons, which clearly result in damage, and which may reasonably be considered to be beyond the Contractor's reasonable control, as determined by the Owner's representative.

C. MAINTENANCE FOR GENERAL LAWN AREAS

1. Maintain grassed areas up to provisional acceptance and a minimum of one full growing season after provisional acceptance to establish an acceptable lawn. For areas seeded in fall, continue maintenance through the following spring until acceptable lawn is established.
2. Maintain grassed areas by watering, mowing, fertilizing, weeding, debris removal and trimming.
3. The Contractor shall mow all established seeded areas. No mowing shall remove more than one-third of the grass blade length. Heavy mowing, resulting in grass on the surface shall be “doubled mowed” or the contractor shall remove grass on surface. The grass shall be mown to a height of two and one half to three inches (2-1/2”-3”).
4. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary to meet the requirements specified herein.
5. Watering of seeded areas.
    a. During this period, water grass as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of two (2) inches of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented by watering by the contractor.
6. Repair areas damaged by erosion or construction activities by regrading, rolling and replanting.
7. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed and hydro mulch.

END OF SECTION

Section 32 92 30
SODDING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
   1. Application of sod.
   2. Watering of sodded areas.
   3. Mowing of sodded areas.
   4. Acceptance of sod.
   5. Disclaimer.
   6. Guarantee.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
   2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
   3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
   4. 31 00 00- Earthwork

1.3 REFERENCES

A. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.4 QUALITY ASSURANCE

A. Subcontract sodding work to a firm specializing in such work unless contractor is fully experienced and qualified.

1.5 SUBMITTALS

A. Certifications and/or labels of proposed sod composition stating common and scientific names of grasses, percentages by weight, and percentages of purity and germination.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Sod, which has been damaged or has deteriorated in transit or storage are not acceptable.

C. Lay sod within 36 hours of harvesting.

D. Planting Schedule: Prepare a proposed sodding schedule. Schedule dates for each type of landscape work during normal seasons for such work.

Sodding: April 1 - June 30

August 15 – October 31

E. Correlate with specified maintenance periods to provide maintenance to date of acceptance. Once the schedule is accepted, revise dates only as approved in writing, after documentation of reasons for delays.

1.7 MAINTENANCE

A. Maintenance of sodding to be performed by the installer includes:

1. Watering.
2. Regrading and resodding of eroded areas.
3. Patching sparse or bare areas.
4. Mowing.

B. Maintain grass areas immediately after placement until grass is accepted.

PART 2 - PRODUCTS

2.1 SOD

A. Sod shall be locally grown, and exhibiting a dense mat of uniformly thriving grass and root tillers held tightly together by earth.

B. The sod shall be good quality, relatively free of any and all diseases, pests and mineral deficiencies and shall conform to the following blended grass mixture; or approve substitute:

Type	% by Weight
Baron Kentucky Bluegrass	30%
Merion Kentucky Bluegrass	20%
Touchdown Kentucky Bluegrass	30%
Jamestown Chewing Fescue	10%

C. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 1/2 inch, plus or minus 1/4 inch, at the time of cutting. Measurement for thickness shall

exclude top growth and thatch.

D. Pad Size: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus ½" on width and plus or minus 5% on length. Pads that are broken, torn, or uneven will not be acceptable.

E. Strength of Sod Sections: Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10% of the section.

F. Moisture: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

G. Mowing Height: Before harvesting, the turf shall be mowed uniformly at a height of 1 to ½ inches.

2.2 SOD ACCESSORIES

A. Wood Pegs: Softwood sufficient size and length to ensure anchorage of sod on slope. Pegs must be able to penetrate from top of sod to at least two (2) inches into the subsoil.

B. Mesh: Interwoven hexagonal plastic mesh 2" size.

2.3 WATER

A. Clean, fresh potable water.

PART 3 - EXECUTION

3.1 APPLICATION OF SOD

A. Time Limitations: Sod shall be harvested, delivered and installed within a period of 36 hours. Sod not transplanted within this period shall be inspected and approved by the inspecting officer or their representative prior to its installation.

B. Moistening the Soil: After all grading has been completed, the soil shall be irrigated within 12-24 hours prior to laying the sod. Sod should not be laid on soil that is dry and powdery.

C. Starter Strip: The first row of sod shall be laid in a straight line with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to insure that the sod is not stretched or overlapped and that all joints are butted tight in order to prevent voids which would cause air drying of the roots.

D. Cutting of Sod: The Contractor shall cut the sod to the lines indicated on the plans.

E. Sloping Surfaces: On sloping areas, where erosion may be a problem, sod shall be laid across the slope with staggered joints and secured by pegging.

3.2 WATERING OF SODDED AREAS

A. The landscape contractor or agreed upon party shall be responsible for watering sod

immediately after installation to prevent drying during progress of work. It shall then be thoroughly irrigated to a depth sufficient that the underside of the new sod pad and immediately below the sod are thoroughly wet. The general contractor shall be responsible for having adequate water available at the site prior to and during installation of the sod.

B. The contractor shall keep all sodded areas watered and in good condition, resodding if and when necessary for the 8 week final acceptance period as outlined in 3.4 D of this specification.

C. During this period, water turf as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent moisture is the equivalent of one (1") inch of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented as required by periodic watering.

3.3 MOWING OF SODDED AREAS

A. The contractor shall keep all sodded areas maintained in an approved condition for the 8 week final acceptance period, including mowing as outlined in 3.4 D. of this specification.

B. Grass height of sodded areas shall be maintained between 1-1/2 and 2-1/2 inches unless otherwise specified. Not more than 1/3 of the grass leaf shall be removed by the initial cutting or subsequent cuttings.

3.4 ACCEPTANCE OF SOD

A. Provisional acceptance of the installed sod shall be within 14 days of completion of an area or section unless otherwise specified.

B. It shall be the contractor's responsibility to keep records of the date(s) of installation of the Area(s) of sod and to notify the landscape architect upon completion of the 14 day period(s).

C. Provisional acceptance will not be granted until contractor has obtained a written statement from the landscape architect indicating that sod is satisfactory.

D. Final acceptance will not be given for a minimum of 8 weeks after provisional acceptance, during a growing season as outlined in 1.6 D of this specification, and only upon written statement from landscape architect verifying that sod is satisfactory.

3.5 DISCLAIMER

A. The landscape contractor shall not be held liable for damages incurred to sod caused by deicing compounds, fertilizers, pesticides, herbicide or other material not applied by him or under his supervision nor for those caused by act of God or vandalism.

3.6 GUARANTEE

A. The contractor shall guarantee work covered by this specification to the extent that all transplanted turfgrass sod shall be uniform in color, leaf texture and shoot density, and be reasonably free of visible imperfections at acceptance.

END OF SECTION

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Section 32 92 40

SEEDING FOR NON-LAWN AREAS

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all materials, equipment, and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to the following:

1. Application of seed
2. Acceptance of seeding

C. Related Sections

1. Section 32 92 00, Soil Preparation for Lawn Establishment

D. In general, seeding for non-lawn areas shall, at a minimum, include road and parking edges, along property lines and all other areas specifically noted on the plans.

1.3 RESTRICTIONS

A. Prior to seeding, contractor shall clearly and plainly mark his limits as indicated on plans.

B. No work shall be performed prior to field determination and approval from Owner's Representative.

1.4 QUALITY ASSURANCE

A. Subcontract seeding work to a firm specializing in such work unless Contractor is fully experienced and qualified.

B. Each seed bag or container shall display a label which identifies the contents as a true representation of the seed mix and percentages required by specification. No seed shall be applied to a site until display labels are submitted to the Owner's representative and has determined the mixture meets all requirements.

C. Do not make substitutions without written approval. If specified seed mixes are not available, obtain approval for substitution from the Owner or Owner's Representative.

1.5 SUBMITTALS

A. Certifications and/or labels of proposed seed mixtures stating common and scientific names of plants, percentages by weight, and percentages of purity and germination.

B. Product information for all proposed weed control chemicals.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Seed mixes which have been damaged or have deteriorated in transit or storage are not acceptable.

C. Seeding Schedule: Prepare a proposed seeding schedule. Schedule dates for each type of landscape work during normal seasons for such work.

Seeding: March 15 - June 30
August 15 - October 15

D. Correlate with specified maintenance periods to provide maintenance to date of acceptance. Once the schedule is accepted, revise dates only as approved in writing after documentation of reasons for delays.

1.7 WARRANTY

A. Warranty seeding until final acceptance of grass stand.

1.8 MAINTENANCE

A. Maintenance of seeding to be performed by the installer includes:
1. Watering
2. Regrading and replanting eroded areas
3. Seeding or patching sparse or bare areas
4. Debris removal
5. Replacement of damaged or dead material
6. Additional weed removal

B. Maintain seeded areas immediately after placement until seeded areas are accepted as outlined in Part 3 of this specification.

PART 2 – PRODUCTS

2.1 SEED

A. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

B. General: Pure, live, fresh seed from commercial sources, meeting and labeled in accordance with State and Federal laws, rules, and regulations. Contractor shall provide labels of all seed used indicating species and percentages. All seed to have minimum germination rate of 85% unless otherwise noted.

C. **Restoration Seed Mix** as indicated on the Plans shall be "New England Semi Shade Grass and Forb Mix" as supplied by New England Wetland Plants, Inc. or approved equivalent. Percentages of species shall be per New England Wetland Plants specifications.

Seed Botanical Type

Elymus virginicus
Festuca rubra
Elymus Canadensis
Chamaecrista fasciculata
Panicum clandestinum
Asclepias syriaca
Penstemon digitalis
Desmodium canadense
Zizia aurea
Geum canadense
Heliopsis helianthoides
Eupatorium maculatum
Eupatorium purpureum
Aster cordifolius
Euthamia graminifolia
Aquilegia Canadensis
Mondarda fistulosa
Solidago caesia
Agrostis perennans

Seeding Rate: 30lbs/acre

C. **Low Maintenance Seed Mix** as indicated on the Plans shall be "New England Erosion Control/Restoration Mix for Dry Sites" as supplied by New England Wetland Plants, Inc. or approved equivalent. Percentages of species shall be per New England Wetland Plants specifications.

Seed Botanical Type

Festuca rubra
Elymus Canadensis
Lolium multiflorum
Lolium perenne
Bouteloua gracilis
Schizachyrium scoparium
Sorghastrum nutans
Agrostis scabra
Agrostis perennans

Seeding Rate: 35 lb/acre

D. **No Mow Grass Mix** as indicated on the Plans shall be "No Mow Lawn Seed Mix" as supplied by Prairie Nursery, or approved equivalent. Percentages of species and species list shall be per Prairie Nursery specifications.

Seeding Rate 5 lbs/1000 sf

2.2 COVER CROP SEEDING

A. Cover crop seeding shall be applied to all areas designated as Restoration Seed Mix and Low Maintenance Seed Mix as shown on the Plans.

B. Cover Crop Seed Mix shall be Annual Rye.

C. Annual Rye Cover Crop shall be applied at 30 lbs/acre unless otherwise included in seed mix.

2.3 WATER

A. Clean, fresh potable water free of salt and other impurities injurious to vegetation.

PART 3 – EXECUTION

3.1 GENERAL

A. Restoration Seed Mix shall be placed along property lines and all other areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans.

B. Low Maintenance and No Mow Grass Seed Mixes shall be placed in locations shown on the plans.

3.2 APPLICATION OF SEED

A. **Seeding shall not occur until the seed bed has been approved per Specification 32 92 00, Section 3.1.**

B. The approved seed mixture shall be applied at a rate specified by each particular type of seeding, by means of a mechanical spreader or by hand on to prepared soil. Seed shall be lightly raked or rolled to ensure soil contact.

C. Distribute seed over area in two separate passes, each one perpendicular to the other (north-south, east-west orientation). Each pass shall be in a linear progression, and shall conform to the field direction that permits the longest straight line application procedure.

D. Hydro mulch shall be applied to seeded areas after seeding has occurred. Hydroseeding shall not be permitted for seeded areas specified herein.

E. Broadcast seeding will be permitted only with permission of Owner or Owner's Representative. All requests shall be in writing with detailed and itemized procedure to be followed.

3.3 CARE OF SEEDED AREAS

A. Watering: Contractor shall water all seeded areas immediately after seeding operations and on a regular basis over the first 2 to 3 weeks until germination is complete.

B. Refer to Section 3.4, C for additional maintenance requirements.

3.4 ACCEPTANCE OF SEEDING

A. PROVISIONAL ACCEPTANCE

Provisional acceptance shall be considered after a minimum of **ONE** full growing season as indicated in Section 1.6 Paragraph C. In order for provisional acceptance to be granted, the Contractor shall request in writing to the Owner's Representative that he/she is ready to have the seeded areas reviewed. The following requirements shall be met.

1. Provisional acceptance will not occur until after one full growing season. The seeded areas are well established, exhibiting a vigorous growing condition and devoid of bare spots greater than 1 square foot.
2. It will be the contractor's responsibility to maintain seeded areas from the time of seed installation until the date of Final Acceptance. See Section 3.4, C. herein for maintenance requirements.
3. Provisional acceptance will not be granted until contractor has obtained, in writing, a statement from the landscape architect indicating that grass is satisfactory under the terms of the provisional acceptance.
4. Following are some examples of delays in provisional acceptance of seeded areas:
   a. Improper grading:
      -Low or high spots on flat or fairly level areas
      -Improper drainage
      -Washed out or rilled areas
      -Exposed debris
   b. Turf Grass Conditions
      -Poor or thin stands of lawn
      -Improper fertilization application
      -Persistent weeds established in turf areas
      -Significant stands of clover are not considered persistent weeds in areas seeded within this specification

B. FINAL ACCEPTANCE

In order for final acceptance to be granted, the Contractor shall request in writing to the Owner's Representative that he/she is ready to have the seeded areas reviewed. The following requirements shall be met.

1. All seeded areas have been maintained by the Contractor for not less than one growing season from the time provisional acceptance is granted. Growing season shall be defined as follows:
   a. If provisional acceptance is received during April, May, June or July, next growing season shall end on October 15.
   b. If provisional acceptance is received during September, October, November or December, next growing season shall end on June 1.
2. Inspection will be made by the Owner's Representative and the Landscape Architect. Grass areas not demonstrating satisfactory stands as outlined above, (except if damaged by vandalism) as determined, by the L.A. shall be renovated, re-seeded, and maintained meeting all requirements as specified herein. Maintenance period shall extend to the end of the next growing season, see Section 3.4, B.1 herein.
3. After all necessary corrective work has been completed, the Landscape Architect will submit in writing recommending to the Owner's Representative that Final Acceptance shall be granted.
4. Decision of Owner's Representative as to the necessity to replace grass areas or repair any defects in workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be the same as specified. All replacements shall be planted as specified herein at Contractor's expense.

5. "Vandalism", as noted above, is intended to mean any acts, whether intentional or accidental, by other persons, which clearly result in damage, and which may reasonably be considered to be beyond the Contractor's reasonable control, as determined by the Owner's representative.

C. MAINTENANCE

1. Maintain grassed areas up to provisional acceptance and a minimum of one full growing season after provisional acceptance to establish an acceptable cover of vegetation. For areas seeded in fall, continue maintenance through the following spring until acceptable seeded areas are established.
2. Maintain grassed areas by watering, mowing, fertilizing, weeding, debris removal and trimming.
3. Mowing.
   a. No Mow Seed Mix should be mowed once or twice a year following recommended practices established by Prairie Nurseries.
   b. Restoration Seed Mix and Low Maintenance Seed Mix shall be mowed using a weed-eater to a height of 8” whenever height reaches 18”. Trimming lower than 4” will kill many species in the mixes. Problem weeds such as thistle and burdock should be spot treated or hand-pulled each year, including the establishment year.
   c. Additional Care: Contractor shall follow recommended practices established by seed Source Company for fertilization, de-thatching, cutting back, aerating and overseeding for the maintenance period specified herein. The Owner should follow same recommended practices after final acceptance.
4. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary to meet the requirements specified herein.
5. Watering of seeded areas.
   a. During this period, water seeded areas as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of two (2) inches of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented by watering by the contractor.
6. Repair areas damaged by erosion or construction activities by regrading, rolling and replanting.
7. Reseed small, sparse vegetated areas. When sparse areas exceed 20 percent of planted area, reseed and hydro mulch.

END OF SECTION

Section 32 92 50

SOIL PREPARATION FOR RAIN GARDENS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings, or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Mixing of Sand, Loam and Compost
2. Grading and Spreading of Soil Mix

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
4. Section 31 00 00 – Earthwork
5. 32 92 40 – Seeding for Non-Lawn Areas6.
6. Section 32 93 10 – Trees, Shrubs and Groundcovers

1.3 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years of experience on similar projects.

B. Contractor shall not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

1.4 SUBMITTALS

A. Certified analysis and source of off-site loam to be provided. Certification shall list soil additives to loam including rates and type.

B. Certification and/or labels of proposed soil additives stating names of each.

C. Certified analysis and source of compost to be provided.

D. Certified analysis and source of sand to be provided.

1.1 DEFINITIONS

A. The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.6 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than one inch (1”) in any dimension and which will prevent healthy plant growth.

B. Loam shall be one of the following sandy loams: “coarse sandy loam”, “sandy loam”, “fine sandy loam” based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

	Percent Passing By Weight	
Millimeter	Max.	Min.
2	---	100
1	100	80
0.5	87	67
0.25	78	48
0.10	68	30
0.05	55	22
0.02	7	2

1. One hundred percent shall pass a one inch sieve opening, and the maximum retained on the quarter inch sieve shall be 20 percent by weight of the total sample.

2. On-site and off-site loam shall be screened to achieve the above specified sieve analysis.

C. Organic Content and pH: Loam shall contain not less than 6% or more than 10% organic matter determined by wet combustion method on sample dried at 105 degrees C. Acidity range shall be pH 6 to 7 in seeded areas when tested according to methods of testing or A.O.A.C.

1. Loam Borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the project site.
   a. When pH of loam borrow is equal to or greater than 7 use aluminum sulfate to adjust pH to required levels.
   b. When pH of loam borrow is less than 7 use either sulfur or ferrous sulfate to adjust pH to required levels.

D. The loam borrow must not be handled or moved when in wet or frozen conditions.

E. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

2.2 COMPOST

A. The Contractor shall notify the Owner or Owner's Representative of the intended source of loam to be employed at least two (2) weeks prior to the intended time of use to allow time for sampling.

B. Shall be made from aged organic materials, free from sticks, stones and/or other substances which would be injurious to health plant growth.

C. The compost shall be screened to remove all materials one inch (1") and larger.

D. Organic matter of compost shall constitute between ten percent (10%) and twenty percent (20%).

2.3 SAND

A. Sand shall be a gravelly sand meeting ASTM D 422.

B.

Sieve size	Percent passing
2"	100%
¾"	70-100%
¼"	50-80%
No. 40	15-40%
No. 200	0-3%

PART 3 - EXECUTION

3.1 MIXING OF LOAM, SAND AND COMPOST

A. Thoroughly mix the Loam, Sand and Compost at the following percentages:

40% Sand

20-30% Loam
30-40% Compost
Percentages are by volume.

B. The Loam/Compost mix shall be fully and thoroughly blended.

3.2 GRADING AND SPREADING OF SOIL MIX

A. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam/Compost shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials. Loam/Compost mix shall be spread to produce a total depth of **18"** or as otherwise shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading of loam/compost mix, then shape and finish grade to depth required.

END OF SECTION

Section 32 93 10

TREES, SHRUBS, AND GROUNDCOVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:

1. Layout and Excavation of Plant Holes
2. Planting and Backfilling
3. Watering.
4. Mulching.
5. Fertilizing.
6. Staking and Guying.
7. Antidessicant Application.
8. Tags and Labels.
9. Maintenance.
10. Plant Replacement Guarantee.

1.2 RELATED REUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 REFERENCES

A. ANSI Z260.1 - Nursery Stock, latest edition (American Association of Nurserymen, Inc.).

1.4 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years experience on similar projects.

B. An arborist, licensed by the state in which the work is to be performed, is required for all pruning work.

C. At least three (3) shrub of each variety and all trees shall be tagged with a waterproof tag bearing legible designation of botanical and common names, and all other standard products shall be delivered sealed and unbroken.

D. Do not make substitutions without written approval. If specified landscape material is not available, obtain approval for substitution from the Owner or Owner's Representative.

E. Where formal planting arrangements are shown, select stock with uniform height and spread, and label with numbers to assure symmetry in planting.

F. The Owner and/or the Owner's Representative reserves the right to inspect all plant materials for compliance with specifications, and to reject unsatisfactory or defective work at any time during progress of work.

1.5 SUBMITTALS

A. Certified analysis and source of off-site loam, used to backfill to be provided. Certification shall list soil additives to topsoil, rates and type.

B. Certifications and/or labels of proposed plant materials or substitutions, listing common and scientific names of each.

C. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).
2. Local/regional materials (LEED Credit MRc5):
    a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
    b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Plants which have been damaged or have deteriorated in transit or storage are not

acceptable.

C. Keep plants moist, fresh, and protected against exposure to sun, wind, and freezing temperatures whether in the receiving yard, in transit, while being handled, or at the job site awaiting planting.

D. Deliver trees, shrubs and groundcover after preparations for planting have been completed and plant immediately.

E. Planting Dates: Prepare a proposed planting schedule. Schedule dates for each type of landscape work during normal seasons for such work. Once the schedule is accepted, dates shall be revised and submitted in writing for reasons of delay.

Planting Deciduous material:	Spring March 1 to June 15
Fall	September to December 1
Evergreen material:	Spring March 15 to May 30
Fall	August 15 to November 15

F. Those species known to be fall digging hazards shall be dug during the spring season only. Fall planting of these species shall be permitted only with certification, from the nursery, of the time of digging and at the discretion of the Owner or Owner's representative.

G. Correlate planting schedule with specified maintenance periods to provide maintenance to date of acceptance.

H. Coordination with Lawns: Plant trees, shrubs, and groundcover after final grades are established and prior to planting of lawns, unless otherwise acceptable to Owner or Owner's Representative. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.7 SPECIAL CONDITIONS

A. Should discrepancies exist between plant quantities or plant sizes as shown in the Planting Schedule and on the Planting Plan, quantities and sizes shown on the Planting Plan shall govern. Contractor shall then install all plants as shown on the plan at no additional cost to the owner.

1.8 WARRANTY

A. Provide a warranty for tree, shrub and groundcover plantings for a minimum of one year including one continuous growing season. Commence warranty on date identified in the Certificate of Final Completion.

B. Warranty: Include coverage of plants from death or unhealthy conditions.

C. Replacements: Plants of same size and species as specified, planted as soon as possible in the next growing season, with a new warranty and an extended maintenance service commencing on date of replacement.

1.9 MAINTENANCE

A. Maintenance of tree, shrub and groundcover planting to be performed by Installer Include:

1. Watering, weeding, cultivating and mulching.
2. Tightening, guy webbing and repairing of stakes.
3. Replacing of dead material.
4. Resetting plants to proper grades, or to upright position.

PART 2 - PRODUCTS

2.1 LOAM COMPOST MIX

A. For Loam Compost Mix, refer to Section 32 93 00, “Part 2 – Products”.

B. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than one inch (1”) in any dimension and which will prevent healthy plant growth. Organic matter shall constitute not less than five percent (5%) nor more than twenty percent (20%) as determined by wet combustion method (Chromic acid reduction). The Contractor shall notify the Owner or Owner’s Representative of the intended source of loam to be employed at least two (2) weeks prior to the intended time of use to allow time for sampling.

C. Loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where: N 85% of sand size is 0.5 to 1.0 mm and N 95% of sand mix is between 0.5 and 2.0 mm and no more than 5% of mix is less than 0.5 mm.

D. Acidity range of approximately pH 5.5 to 7.5 when tested according to methods of testing or A.O.A.C. and organic content not less than 5% nor more than 20% as determined by wet combustion method (Chromic acid reduction).

2.2 ANTIDESSICANT

A. Emulsion which permits transpiration while retarding excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix according to manufacturer's direction. Use "Wiltproof" or equal approved.

2.3 TREE AND SHRUB FERTILIZER

A. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified

B. Complete fertilizer in granular form, from commercial sources bearing manufacturer’s analysis; 2-3-3 ratio of N-P-K.

1. Total Nitrogen (N) – 2.0%
   a. 0.8% - Water Soluble Nitrogen
   b. 1.2% - Water Insoluble Nitrogen
2. Available Phosphate (P_2O_5) – 3.0%
3. Soluble Phosphate (K_2O) – 3.0%

C. Application Rate: Apply 2-3 pounds per 100 square feet

2.4 STAKE AND GUYING MATERIALS

A. Guy web: Shall be a low abrasion woven fiber webbing with a break strength of 900 pounds or better. The width of the webbing shall be no less than 5/8 inch nor greater than ¾ inch. The length shall be sufficient enough to be attached to the tree trunk and stake.

B. Stakes: Shall be on a hardwood source, free of knots, insects and fungi. Stakes shall be of uniform size and shape and shall be a minimum of two inches (2") square. Stakes shall be pointed with a taper of no less than four inches (4").

C. The above ground stake height shall be eight inches (8") above the point of attachment. The type of stakes shall be uniform throughout the job.

2.5 MULCH

A. Pine Bark Mulch shall be derived from evergreen tree bark aged to a minimum of six months and no more than eighteen months. The bark shall be shredded so that the resulting pieces are no more than ¼ inch thick and no longer than three inches (3"). The mulch shall be free of stringy material and shall not contain an excess of fine particles. The mulch shall be brown in color, free of leaves, twigs, sod, weeds, shavings and other foreign materials which are injurious to health plant growth.

2.6 WATER

A. Clean, fresh potable water free from injurious chemicals and other toxic substances harmful to plant life. No brackish water will be permitted.

2.7 PLANT MATERIALS

A. Plant materials shall conform in size, grade and quality to the "American Association of Nurserymen Standards for Nursery Stock" as amended by the United States of America standards institute, in effect at the time of bidding.

B. Plants of other kinds than those named in the Plant Schedule on the Drawings shall not be accepted without written approval of Owner or Owner's Representative.

C. Unless otherwise approved by Owner or Owner's Representative, all plants shall be nursery-grown in accordance with good horticultural practices and shall have been grown under climatic conditions similar to those in the locality of the project for at least two (2) years. They shall have been transplanted or root pruned at least nine (9) months previous to moving to the site.

D. All plant material shall comply with the state and federal law with respect to inspection for plant disease and insect infestation.

E. Replacement plants larger in size than existing may be used if approved by Owner or Owner's Representative, provided use of larger plants does not increase Contract price.

F. If use of larger plants is approved, increase ball of earth of spread of roots in proportion to size of plant.

PART 3 - EXECUTION

3.1 PLANTING

A. Layout: **Determine location of underground utilities and layout plants so as to avoid possible damage to such structures.** Plant pits and bed locations as shown graphically and/or verbally on plans, shall be staked on ground by contractor and approved by the Owner's Representative prior to excavation. Should discrepancies exist between plant quantities in Planting Schedule and Planting Plan, quantities shown on the Planting Plan shall govern. Adjustments in locations and outline shall be made as directed in field. Labor, equipment, and new smooth stakes are to be furnished by the Contractor for this purpose.

B. Excavation: Planting beds and pits shall conform to the approved staked locations and outlines. Holes dug for plantings shall in all cases be large enough to include the complete root system of the plant (tree, shrub, and groundcover) to be received and also sufficient amounts of approved backfill mix around the periphery of the rootball. All sod, weeds, roots, cobbles, and stones and other objectionable materials excavated from the plant holes which is unsuitable for backfill shall be removed from the site immediately and legally disposed of.

C. Plant Hole Size: The minimum plant hole size, unless otherwise specified, shown on the plans or directed by the Owner's Representative shall be as follows:

Trees and Shrubs - The planting hole shall be three (3) times the diameter of the rootball in width and no deeper than two inches (2") less than the distance from the bottom of the rootball to the root collar (i.e. a 12" distance between the bottom of the rootball and the root caller will require a 10" deep hole). Any excavation in excess of that required shall be replaced and compacted to eighty-five percent (85%) of maximum density.

Groundcover - The planting hole shall be twice the diameter of the rootball in width and equal to the depth from the bottom of the rootball to the level at which it was grown in the nursery. Any excavation in excess of that required shall be replaced and compacted to eighty-five percent (85%) of maximum density.

Any rocks or underground obstructions shall be removed to a depth necessary for planting as specified, unless alternate locations for the planting are approved by the Owner's Representative. If removal of obstructions result in a deeper hole than specified for planting, backfill material shall be added and compacted to eighty-five percent (85%) of maximum density to the correct depth.

D. Backfill Mix: Add loam to suitable soil excavated from the planting hole to create mix for planting pits. Backfill Mix shall be at least fifty percent (50%) loam.

3.2 SETTING PLANTS

A. Plants shall be handled in such a manner that the soil of the rootball will not be loosened from the roots. Carefully place plant into the prepared hole. Set plants plumb and fill in around the rootball to one half (1/2) the depth of the hole with backfill mix. Thoroughly tamp the backfill mix to eighty-five percent (85%) of maximum density.

B. Fill remaining area of planting hole with water. Once the water has completely drained loosen burlap and peel down at least the top one-third (1/3). If wire baskets are used, cut and bend down top one third (1/3) of basket. Roots that have been wrapped around the ball within the burlap shall be made to lay in as natural a manner

as possible. Cut broken or frayed roots cleanly.

C. Fill remaining area of hole with backfill mix and thoroughly tamp to eighty-five percent (85%) of maximum density. Form a saucer around the edge of through backfill hole by constructing a berm. The finish height of the compacted berm shall be three inches (3”). No excess soil shall be allowed to remain within the plant saucer. Fill saucer with water.

3.3 PRUNING OF NEW PLANT MATERIAL

A. After planting prune only dead, broken or deformed branches and in such manner as to preserve natural character of plant.

B. Perform all pruning with sharp tools, with cuts flush and clean. Do not apply paint or asphalt emulsion tree wound compound on cut area.

C. Trees which have had their leaders cut, or so damaged that cutting is necessary, will not be accepted. There shall be no abrasion of bark, nor fresh cuts of limbs over 1/2".

3.4 WATERING

A. The plants shall be watered immediately following planting.

B. Soak the plants thoroughly again within a twenty-four (24) hour period after the initial planting.

C. Additional watering shall be made at least once every three weeks, unless otherwise directed, until final acceptance of the plant material.

3.5 FERTILIZING

A. During backfill operations, place fertilizer in upper foot of back fill around perimeters as recommended by manufacturer.

3.6 MULCHING PLANTS

A. Application of mulch should only occur after planting operations have been completed and initial watering has taken place. Mulch shall be applied no latter than forty-eight (48) hours after planting.

B. Prior to the placement of mulch, the contractor shall apply a pre-emergent weed control within the entire area to be mulched. Pre-emergent weed control shall be applied by a licensed commercial applicator at a rate in accordance with the manufacturer’s installation.

C. Mulch shall be applied a minimum of three (3) inches in depth for all individual trees and planting beds, as indicated graphically or verbally on the drawings.

D. Where mulch abuts seeded lawn areas or other finish grade materials, edge of planting bed shall be cut smooth and cleanly. Mulch shall be placed carefully so as not to spill into adjacent areas. Any excess or spilled mulch shall be promptly removed from the project area.

3.7 GUYING AND STAKING

A. Immediately after planting, stake trees as indicated on detail drawing or as directed by

Owner or Owner's Representative.

B. Place stakes outside of the planting pit exercising care not to damage the soil berm.

C. Guy all trees with a caliper of two inch (2") or greater and all evergreen trees greater than four feet (4'). Guy webbing shall be attached at a point no higher than one half (1/2) the height of the tree or lower than one-third (1/3) the height of the tree.

D. Guy trees to each stake near top of stake and intertwine webbing at tree trunk. The guy webbing shall lay flat against the trunk. Draw guy webbing tight enough to remove slack but shall not cause deflation or strain to the plant.

3.8 TRUNK WRAPPING

A. Remove all trunk wrap and trunk protection devices prior to staking and guying operations unless otherwise directed by the Owner's Representative.

3.9 ANTIDESSICANT SPRAYING

A. Spray antidessicant as directed by the manufacturer's recommendation.

3.10 TAGS AND LABELS

A. Leave all tree tag and label seals unbroken and visible on plant material until final inspection. Remove all seals immediately after final inspection.

3.11 MAINTENANCE

A. Contractor is responsible for protection and maintenance of all work prior to final acceptance. No plants will be accepted unless they show a healthy growth and satisfactory condition.

B. Maintenance work for all plantings shall be as listed in section 1.9.

3.12 PLANTING ON BANKS

A. Apply jute mesh loosely but smoothly to fit the contour of the finished grade, parallel to and in same direction as the flow of water. The up-slope end of each separate strip or piece of jute mesh shall be buried in a six (6) inch minimum vertical anchor slot or junction slot with the soil tamped firmly against the mesh. Where more than one width of material is required, edges shall overlap a minimum of twelve (12) inches, and the up-slope section of mesh will be on top. Down-hill ends of the jute mesh shall be folded under approximately four (4) inches and stapled in place. Staples will be inserted through the mesh along edges, overlaps, and in the center of all jute mesh strips at intervals not greater than three (3) feet. All anchor slots, junction slots, check slots, and terminal folds shall have five (5) staples spaced not more than nine (9) inches on center across widths.

B. On seeded banks, jute shall be applied immediately after seeding. On shrub banks, apply jute after finish grading. Cut openings in mesh for each plant and mulch as specified.

3.13 PLANT REPLACEMENT GUARANTEE

A. Guarantee that, upon completion and final acceptance tree, shrub and groundcover

planting conforms to requirements of contract documents and that all plants except transplant materials are healthy and will remain so for a period of one (1) year. Such period shall commence with date of final acceptance.

B. At any times within period of guarantee, Contractor shall replace any plantings which for any reason, other than vandalism, has died or is in a dying condition, or which has failed to flourish in such a manner or to such a degree that its usefulness or appearance has been impaired.

C. The Owner will not maintain plantings until after guarantee period. Contractor shall not have any claim that materials have failed to flourish as a result of Owner's maintenance operations, or lack of maintenance, and shall abide by terms stated herein for guarantee and replacement of plant materials.

D. Decision of Owner as to necessity to replace any plant materials or repair any defects on workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be of same species and size as specified on Plant List. All plant replacements shall be inspected, sealed, furnished, planted and mulched as specified herein at Contractor's expense.

E. "Vandalism", is intended to mean any acts, whether intentional or accidental, by other persons occurring following final acceptance, which clearly result in breakage or other damage to individual plants or plant beds, and which may reasonable be considered to be beyond Contractor's reasonable control, as determined by the Owner's representative.

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Section 33 05 13

DRAINAGE MANHOLES AND CATCH BASINS

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 WORK TO BE PERFORMED

A. The work covered in this Section of the Specifications includes construction and placement of all precast reinforced concrete drainage manholes, catch basins, castings for drain covers and frames, rungs and all appurtenant and incidental work, complete, in strict accordance with the Specifications and the applicable Drawings.

1.3 REFERENCES

A. All work specified in this Section shall conform to the standard requirements of the City of Beverly and the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as “State Standards” Specifically Section 200, 230, and 140.

B. American Society for Testing and Materials Standards.

1. All gray iron castings shall conform to the requirements of AASHTO Designation M105, Class 30 and ASTM A48-74. Test both cover and frame, for H-20 Highway Loading.
2. Ductile iron castings shall conform to ASTM A 536. Grade 60-40-18 unless otherwise specified.
3. Cast steel shall conform to ASTM A27. Grade 70-36 and shall be thoroughly annealed.

1.4 SUBMITTALS

A. Submittals for the following items shall be made in accordance with the requirements as specified in Section 01 33 00, SUBMITTAL PROCEDURES.

1. The drawings shall show the setting plans, exact profile of each units, openings required, all inserts and other items which are to be embedded in the units.
2. Shop drawings showing details of manhole cover and frame, catch basin frame and grate, manhole step castings, construction details, tolerances and other information as required.
3. Shop Drawings showing roof drain connectors and/or adapters.
4. Conformance Certificate: Each shipment of castings and concrete manholes and catch basins shall be accompanied with the manufacturer’s notarized certification that materials meet specified requirements.

1.5 QUALITY CONTROL

A. Provide the following.

1. All pre-cast concrete shall be the product of a manufacturer who has

demonstrated capability to produce pre-cast concrete products of the quality specified. A manufacturer must be able to show that he has experienced personnel, physical facilities, established quality control procedures, and a management capability sufficient to execute the work of this contract. When requested by the Architect, the Contractor shall submit written evidence of the above requirements.

2. Experienced plant personnel shall closely supervise the manufacturing process, and daily records of concrete strength shall be kept and submitted to the Architect for control.

3. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly trained and experienced in the installation of the pre-cast concrete structures and shall direct all work performed under this Section.

1.6 PRODUCT HANDLING

A. Materials and equipment shall be progressively delivered at the site so that there will be neither delay in the progress of the work nor an accumulation of materials that is not to be used within a reasonable time. Materials shall be so stored as to assure the preservation of their quality and fitness for the work.

B. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection.

C. Private property shall not be used for storage purposes without written permission of the owner or lessee, and if requested by the Architect copies of such written permission shall be furnished to him/her. All storage sites shall be restored to their original condition by the Contractor at his expense

1. Avoid damage to castings from impact, abrasion, or corrosion during handling and storage.

2. Use all means necessary to protect pre-cast concrete units and materials before, during and after installation and to protect the installed work and materials for all other trades.

3. In case of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at the Contractor's expense.

PART 2 - MATERIALS

2.1 GENERAL

A. Cement shall be Portland cement conforming to ASTM C150, Type III, high early strength and comply with Standard Specification M4.02.

B. Aggregate: shall conform to ASTM C330 and shall be graded, crushed stone with a resulting unit weight of concrete of up to one hundred fifty five (155) pounds per cubic foot, and a minimum unit weight of not less than one hundred forty-eight (148) pounds.

C. Water: shall be clear and free of injurious and deleterious substances.

D. Concrete: shall have a minimum strength of 5000 psi at twenty-eight (28) days and strength of 3000 psi at the time of form release.

1. During the process of manufacturing of the units not less than two (2) test cylinders shall be tested at time release of the form and two (2) at age twenty-eight (28) days.
2. All compression test cylinders shall be made, cured and stored in accordance with ASTM C31. Cylinders shall be tested in accordance with ASTM C39.
3. All concrete shall contain three (3) to five- (5) percent air entrainment.

E. Admixtures shall only be used after prior approval of the Architect.

F. All reinforcing bars shall conform to the requirements of ASTM designation: A615, Grade 60 and comply with Section 901.61 of the Standard Specification.

G. Welded wire fabric shall conform to the requirements of ASTM designation: A185.

H. All frames and grates shall be H-20.

2.2 PRECAST CONCRETE MANHOLES, CATCH BASINS AND BRICK

A. Precast Concrete Manhole and Catch Basin Sections shall be similar or equal to that shown on the Drawings and shall conform to ASTM Specifications C-478 and C-76 Class IV Wall "B". The horizontal joints between Sections shall be sealed using a flexible butyl resin sealant and shall conform to AASHTO M-198B. In addition, the horizontal joints on the inside and outside of the manhole and catch basin shall be sealed with a "Quick Plug" as manufactured by Parson or equal.

B. Brick shall conform to ASTM Specification C-32 for sewer brick, except that the table therein is amended to provide that the required minimum compressive strength in pounds per square inch shall be for any individual brick 3,000 or 5,000 for the average of five bricks selected at random. The maximum absorption of water by five-hour boiling test shall not exceed 16% for any individual brick or 12% for the average of any five bricks selected at random.

C. Mortar for all brickwork shall be composed of Portland cement and sand in the proportions of 1:2. No mortar cement or lime shall be used. Cement shall be type II Portland Cement as specified for concrete masonry.

D. The dome of the manholes shall be a precast concrete Section. The top 6-inches of the dome, not to exceed 12 inches, shall be built of brick and mortar to permit adjustment of the frame to meet the ground surface.

E. Openings for pipe insertions shall be round and shall be precast or cored only. The diameter of the opening shall be adequate to install a rubber boot seal. The cored or precast opening shall maintain a minimum undisturbed distance of 6” from manhole Section joints. Flexible rubber boot shall be neoprene with stainless steel clamps and bands.

F. The precast bases shall be supported on a compacted level foundation of crushed stone at least 6-inches thick.

G. The barrel shall be at least 48 inches inside diameter with not less than 5 inch thick wall.

H. Sections shall be steam cured and shall not be shipped until at least 5 days after having been cast.

I. The date of manufacture and the name of trademark of the manufacturer shall be clearly marked on the inside of the barrel.

J. The top conical Section shall have a wall thickness not less than 5-inches at the bottom and wall thickness of 8 inches at the top. The conical Section shall taper from a minimum of 48 inches diameter to 36 inches diameter at the top.

2.3 DRAINAGE MANHOLE FRAMES AND COVERS

A. Manhole Frames and Covers shall have a hot-dipped bituminous coating and form to the details on the Drawings. Cast iron shall conform to ASTM A-48, Class 25. The underside of the cover and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and covers shall be machined to prevent covers from rocking in the frames under traffic.

B. Covers shall bear evenly in the frame and both frame seats and covers shall be accurately fabricated so that covers are interchangeable for use with any and all frames. Where indicated, frames and covers shall be watertight, and locked. The sizes and weights (medium duty, heavy duty) are shown on the detail sheets for special manholes.

C. Mortar shall consist of one part cement and two parts clean sand. No lime shall be used.

D. Covers shall have a non-slip surface and shall have the word “DRAIN”, as applicable, inscribed.

E. Frames and covers shall be installed on the manholes as indicated on the Drawings. They shall be well bedded and encased in cement mortar and accurately set to the grades indicated. Red clay brick with cement mortar shall be used to adjust grade of frame and cover. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

F. All frames shall be designed for H-20 wheel loading.

G. Manhole frames and covers shall be specified by the City of Beverly or equal.

2.4 CATCH BASIN FRAMES AND GRATES

A. Catch Basin Frames and Grates shall have a hot-dipped bituminous coating and conform to the details on the drawings. Cast iron shall conform to ASTM A-48, Class 25. The underside of the grate and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and grates shall be machined to prevent grates from rocking in the frames under traffic.

B. Grate shall bear evenly in the frame and both frame seats and grates shall be accurately fabricated so that grate is interchangeable for use with any and all catch basin frames. The sizes and weights (medium duty, heavy duty) are shown on the detail sheets.

C. Mortar shall consist of one part cement and two-part clean sand. No lime shall be used.

D. Gratings shall have a non-slip surface.

E. Gratings shall be installed on the catch basins as indicated on the Drawings. They

shall be well bedded and encased in cement mortar and accurately set to the grades indicated. Red clay brick with cement mortar shall be used to adjust frame and grate. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

F. Catch basin frames and grates shall be as specified by the City of Beverly or equal.

2.5 MANHOLE STEPS

A. Steps shall conform to ASTM C-478.

B. The capacity of each step shall be 1000 lb. At 6-inch distance from wall, 1500 lb. At 4-inch distance from wall.

C. Steps shall measure 12 inches wide (min.) and extend 6 inches from wall.

D. Manhole steps shall be provided in each base, riser and top Section and shall be integrally cast in each; 12 inches O.C.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which work of this Section is to be performed, and correct unsatisfactory conditions that would prevent proper and timely completion of the work. Do not proceed until satisfactory conditions have been corrected.

1. Examine castings for blowholes, porosity, hard spots, shrinkage, distortion or other defects. Check coating for smoothness and tenacity.

B. The installation of all pipes of various materials, structures, and connections to existing pipes/structures shall be made at the locations and elevations as shown on the drawings.

C. All materials and each part of detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect.)

D. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

E. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks in advance of the incorporation in the work of any such

materials.

F. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

G. The inspection of the work shall not relive the contractor of any of his obligations to fulfill the terms of the Contract a herein prescribed by the plans and specifications.

H. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor obligate the Owner to make final acceptance.

I. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

J. All storm drain lines shall be given combined pressure and leakage tests as detailed by the City of Beverly.

3.2 GENERAL

A. Excavation and backfilling requirements for installation of manhole and catch basin structures shall be in accordance with the requirements as specified in Section 31 00 00, Earthwork.

B. Manhole and catch basin barrel and cone Sections shall be set so as to be vertical and in true alignment.

C. Where required for future connections, openings shall be cast in the manholes and catch basins at the proper location and shall be sealed with watertight brick bulkheads or plugs.

D. Drop manholes shall be built in accordance with the details shown on the Drawings and as specified herein.

E. The inverts of all manholes shall be constructed of brick and formed to the details shown on the Drawings.

3.3 CONSTRUCTION AND INSTALLATION

A. Bottom riser Sections of reinforced concrete manholes and catch basins may be either cast-in-place or precast concrete. The top edges, of cast-in-place bottom Sections, shall be formed with a removable steel ring template designed to fit the tongue end of the precast riser Sections.

B. Inverts: Where pipe alignment permits, and where directed by the Architect, the pipe shall be continued through the manhole and the top half carefully and evenly cut away. Where changes in alignment occur, unless otherwise authorized by the Architect, inverts shall be constructed of brick and mortar with a smooth flow line and an even curve in accordance with the plans.

C. Joints: Pipe joints into manholes and catch basins shall be constructed in accordance with the details shown on the plans. Complete details of the boot manufacture and installation shall be submitted for approval. All areas around pipes passing through

walls of manholes and catch basins shall be completely filled with waterproof cement mortar to tightly fill any space through which water can pass. All manhole and catch basin joints between Sections shall also be completely filled with waterproof mortar, both inside and outside, and coated with epoxy sealer inside and out.

D. Bricks shall be laid in a workmanlike manner, true to line, and the joints shall be carefully struck and pointed on the inside. Bricks shall be thoroughly wet when laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The outside of the brickwork shall be neatly plastered with ½" layer of cement mortar as the work progresses. The brickwork shall be satisfactorily bonded to the concrete and cast iron frame. No brick masonry shall be laid in water, or any water allowed to rise on the brickwork until the masonry has set for at least 24 hours.

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Section 33 10 00

WATER DISTRIBUTION

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 REFERENCES

A. All work specified in this Section shall conform to the City of Beverly standards.

B. All work specified in this Section shall confirm to the MASSDEP BRP33 “Distribution System Modifications” permit issued for this project as well as applicable MassDEP public water system regulation.

C. American Water Works Association (AWWA):

1. AWWA C104: Standard for Cement Mortar Lining.
2. AWWA C111: Standard for Rubber Gasket Joints.
3. AWWA C150: Standard for the Thickness Design of Ductile Iron Pipe.
4. AWWA C151: Standard for Ductile Iron Pipe, Centrifugally Cast.
5. AWWA C153: Standard for Ductile Iron Compact Fittings.
6. AWWA C600: Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
7. AWWA C651: Standard for Disinfecting Water Mains.

1.3 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service mains.

B. This Section specifies requirements for furnishing and installing ductile iron pipelines complete and in place for water services.

C. The Contractor shall pay for all costs and fees related to the construction of new water system components and connecting the new water system components to the existing water system including all tap-in and inspection fees and shall file all applications, details and drawings required by the local authority having jurisdiction.

D. Contractor is made aware of the fact the water system at the site constitutes a public water system regulated by the MassDEP.

E. In accordance with MGL chapter 146, section 81 and the State Department of Public safety memorandum dated 6-4-9, all fire mains, hydrants, and underground distribution system components associated with the dedicated fire system must be installed by a sprinkler contractor/sprinkler fitter. Additionally, the installation of fire main/hydrant system must comply with NFPA-24, 2014 as reference by MSBC Chapter 917.

1.4 SUBMITTALS

A. Product Data and Shop Drawings: For each type of product indicated. Submitted and approved by the Architect and the City of Beverly.

B. Field quality-control test reports and disinfection notification: The Contractor shall initially notify and subsequently provide the test reports to the City of Plymouth upon completion of the disinfection and pressure testing.

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

D. A copy of any permits required by local authorities having jurisdiction shall be submitted to the Owner prior to commencing work on the water system.

E. Certificate of Compliance:

1. Each shipment of piping, valves, or appurtenances shall be accompanied with the manufacturer's notarized certificate certifying conformance with the requirements of the Specifications.

1.5 PERMIT

A. The Contractor shall maintain a copy of the BRP 33 "Distribution System Modifications" permit issued by the MassDEP at the site at all times during the work of this Contract.

B. The Contractor shall setup a Preconstruction Meeting with the City of Beverly to finalize approval of layout and details by The City of Beverly prior to commencing work.

C. The Contractor shall obtain all permits required to perform work on the water system without expense to the Owner.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable requirements of the City of Beverly including requirements pertaining to the tapping of water mains and backflow prevention.
2. Comply with applicable City of Beverly standards for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with MassDEP requirements for water distribution systems.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. All water pipe and appurtenances shall be "American Made".

1.7 DELIVERY, STORAGE, AND HANDLING

A. All delivery, storage, and handling of pipe, valves, hydrants, and appurtenances shall be in accordance with manufacturer's recommendations.

B. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

C. During Storage: Use precautions for valves, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

D. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

E. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

F. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

G. Protect flanges, fittings, and specialties from moisture and dirt. Piping or materials damaged during delivery storage or handling shall be replaced at the expense of the Contractor.

1.8 PROJECT CONDITIONS

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

1.9 COORDINATION

A. Coordinate connection to existing water system with Beverly Public Schools facilities personnel.

B. The Contractor shall contact “Dig Safe” at 1-888-Dig-Safe to verify locations of existing underground utilities in areas of proposed excavation prior to commencing any excavation effort.

C. The Contractor shall coordinate any work on the water system with the City of Beverly prior to commencing any work on the existing and proposed water system.

D. The installed work will be subject to a final inspection by representatives of the MassDEP Drinking Water Program.

1.10 MARKING

A. Marking of all pipe shall conform to the requirements of AWWA C151, latest revision, and marking of all fittings shall conform to the requirements of AWWA C153, latest revision.

1.11 MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall furnish at no additional expense to the Owner, the services of pipe manufacturer's representatives for instruction of the Contractor's personnel who will be installing the pipe. The instruction shall include proper handling, installation, and jointing and other construction areas, and shall be for such lengths of time required to fully familiarize the Contractor's personnel with the proper techniques.

PART 2 - PRODUCTS

2.1 GENERAL

A. All water appurtenances are to be American made.

B. All materials shall be reviewed and approved prior to installation by the City of Beverly.

C. Refer to the City of Beverly requirements for a list of approved materials and manufacturers.

2.2 DUCTILE IRON PIPE

A. Ductile iron pipe shall be cement-lined, Class 52, and shall conform to AWWA specifications C150 and C151, latest revision. Ductile iron pipe shall have push-on type joints with the exception that mechanical joints shall be used at all fittings and along straight pipe sections where mechanical joint restraint is required. All pipe shall have a bituminous seal coating on all exterior surfaces.

2.3 FITTINGS

A. Fittings and plugs for use with the ductile iron pipe specified shall be ductile iron, cement lined, bituminous coated with a working pressure rating of not less than 250 psi, conforming to AWWA C153, latest revision, and shall have mechanical joints.

B. The exterior of all fittings, plugs, bolts, and nuts shall be coated with two (2) coats of heavy-duty epoxy protective asphaltic coating after assembly.

C. Bolts and nuts shall be rustproof steel.

2.4 JOINTS

A. Push-on and mechanical type joints for pipe as specified above shall conform to AWWA C111, latest revision. Gasket material for all jointing requirements shall be styrene butadiene (SBR).

B. Lubrication Material is to be food grade quality, kept in original container, and stored according to manufacturer's recommendations.

2.5 CEMENT MORTAR LINING

A. Interior pipe and fitting surfaces shall be covered with a double cement-mortar continuous lining not less than 1/16" thick, of materials, and applied in accordance with AWWA/ANSI C104/A21.4, latest revision.

2.6 STORAGE OF MATERIALS

A. Pipe and related materials shall be stored in locations and in a manner approved by the Engineer. The locations and manner of storage shall be as to minimize handling of the materials.

B. Gaskets are to be stored out of direct sunlight in their original packaging and protected from temperature extremes.

C. The Contractor shall, at all times, be solely responsible for the safe storage of all materials.

2.7 TESTING

A. Manufacturer Testing:

1. Testing of ductile iron pipe shall be done in accordance with AWWA C151, latest revision.
2. Testing of ductile iron fittings shall be done in accordance with AWWA C153, latest revision.
3. Testing of jointing material shall be done in accordance with AWWA C111, latest revision.
4. Testing of the interior coating shall be done in accordance with AWWA C104, latest revision.
5. Certified test reports shall be submitted by the pipe manufacturer.
6. The Engineer shall be notified at least ten (10) days in advance of the date and location of the testing in order to witness the tests.
7. The Contractor shall furnish to the Engineer notarized test reports by an independent testing laboratory, which show compliance of all materials furnished to the requirements specified herein. The test reports shall indicate results and methods employed.

B. Field Testing.

1. Field testing of ductile iron pipe installed for water service shall be performed according to the requirements as specified in Section 3.8 of this specification.

2.8 JOINT RESTRAINT

A. Thrust Blocks are to be designed appropriately for the soils, pipe sizes, and pressures encountered at the job site and are to be installed square and plumb against undisturbed soil so that the joint itself, including any bolts, is accessible. Concrete is to be a minimum compressive strength of 2,000 psi and installed to industry standards.

B. Restraining devices shall be utilized on all mains under the following conditions:

1. Pipeline direction changes (tees, bends).

2. Dead end lines (caps, plugs, valves).
3. Transition pieces (reducers).

C. Thrust restraint may be provided via restrained joint, ductile iron pipe meeting ANSI/AWWA C153, AWWA C151/A21.512, AWWA C111/A21.11, and be approved for use by the City of Beverly. Restrained joint pipe lengths (restrained length) shall be sufficient to restrain thrust imparted by 1½ times the anticipated working pressure but not less than 250 psi and may be more than one full length of pipe.

D. Thrust restraint utilizing tie-rods may be used alone or in combination with other restraint systems and are to be installed as directed by the City of Beverly authorized field staff. All rods shall be protected from corrosion with two coats of bituminous paint or epoxy prior to backfilling.

2.9 TAPPING SLEEVES AND TAPPING VALVES

A. All tapping sleeves shall comply in all respects to AWWA Standard C-110 and the following design standards:
1. Tapping sleeve shall be installed at the location of the existing water main as shown on the plans and details.
2. The tapping sleeve shall be a mechanical type joint to provide pressure - tight installation and be suitable for use with the existing pressurized pipe material. Outlet flange shall be Class 125C, ANSI B16.1.
3. Mechanical joint tapping sleeves shall have totally confined end gaskets and be designed to withstand a minimum of 250 p.s.i. working pressure.
4. Tapping valves shall comply with Section 2.10 - Gate Valves except one end shall be flanged and the other mechanical.
5. Tapping valves shall be provided with an oversized opening to allow the use of full size cutters.

2.10 GATE VALVES

A. Resilient seated gate valves shall meet AWWA C-509 and be UL listed and FM approved. This valve shall be iron-body, bronze mounted, nonrising stem, 4 inch through 12 inch in diameter as shown on the plans and details. All valves are to open as designated by Beverly Public Schools facilities personnel and the City of Beverly Fire Department. All valves are to be mechanical joint.

B. Sizes 4 inch through 12 inch shall be suitable for a test pressure of 250-psi.

C. Valve shall have a minimum of two O-ring stem seals.

D. Bonnet and gland bolts and nuts shall be stainless steel for corrosion resistance.

E. The interior and exterior of valves shall be fully epoxy coated 8 mils thick.

F. Gate valves shall be as manufactured by Mueller or equal.

G. Gate valves shall be iron-body, bronze-mounted solid-wedge gate valves, with bell or mechanical joint ends. Valves shall conform to AWWA Standard Specification for Gate Valves, three (3) inch through forty-eight (48) inch for water and other liquids, Designation C500. They shall be double disk type.

H. Buried valves shall be inside-screw, non-rising stem, having bell or mechanical-joint ends and two (2) inch square operating nuts.

I. Bronze gate-rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves of other shapes, the rings shall be firmly attached to the dates with bronze rivets.

J. Operating nuts shall be turned to the left (counter clockwise) to close all valves.

K. O-ring stuffing boxes shall be used.

L. The T-handle wrenches shall be furnished with each gate valve which shall permit operation from a standing position.

M. All valve boxes shall be adjusted to the final grade.

2.11 STRAIGHT AND TRANSITION PIPE COUPLINGS

A. The center sleeve and end rings of couplings shall be made of ductile iron, meeting or exceeding ASTM A536. The coupling shall accommodate the entire O.D. range in the specified size by use of interchangeable color-coded end rings and gaskets.

B. The coupling gasket shall be made of virgin rubber compound for water use. The SBR shall meet or exceed ASTM D2000-3-BA715. The gasket shall have raised lettering, sizing, and state the proper color code for the appropriate end ring.

C. The coupling shall be equipped with stainless steel bolts, washers, and nuts and conform to the latest edition of the AWWA specification designation C-111 and C-219-06.

D. Straight couplings shall be as manufactured by Ford Model FC1-SH, Smith Blair Model 441, Romac Model 501, Cascade Waterworks Model CDC, or equal.

E. Transitional couplings shall be as manufactured by Ford Model FC2A-SH, Smith Blair Model 441, Romac Model 501, Cascade Waterworks Model CTC, or equal.

F. Straight connections between two ductile iron pipe sections shall be made by ductile iron solid sleeves.

2.12 VALVE BOXES AND COVERS

A. Cast iron valve boxes shall be two-piece adjustable style, sliding type. Barrel inside diameter shall be 5¼ inches with 26-inch top section and 48 inch bottom section lengths adjusted to finish grade.

B. Covers shall be cast iron, 5¼ inch, with the word "WATER" and a direction to open arrow imprinted thereon. Covers shall be the heavy, non-tilting 2” drop style recessed in the top to prevent plow breakage. The boxes and covers shall be compatible with the valves to which they attach.

C. An approved operating key shall be provided to the Owner.

2.13 LIQUID CHLORINE

A. Liquid chlorine shall conform to AWWA Standard B301, current edition. Liquid chlorine shall be NSF 60 certified for potable water use.

2.14 HYPOCHLORITE

A. Hypochlorite shall conform to AWWA Standard B300, current edition. Hypochlorite shall be NSF 60 certified for potable water use.

2.15 BACKFLOW PREVENTER

A. Backflow prevention device used temporarily for any connection between the existing water system and new water pipes prior to acceptance of pressure test, disinfections and flushing, shall be of the appropriate size and shall be double check-reduced pressure type as manufactured by Watts, Febco, Hersey or equivalent. Permanent backflow prevention devices to be installed as part of this project are specified in the plumbing specifications of this Contract.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 00 00 - Earthwork for excavating, trenching, and backfilling.

3.2 INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of MassDEP and City of Beverly standards and of size and in location indicated.

B. In accordance with MGL chapter 146, section 81 and the State Department of Public safety memorandum dated 6-4-9, all fire mains, hydrants, and underground distribution system components associated with the dedicated fire system must be installed by a sprinkler contractor/sprinkler fitter. Additionally, the installation of fire main/hydrant system must comply with NFPA-24, 2014 as reference by MSBC Chapter 917.

C. Pipe, valves, sleeves, hydrants, accessories, and appurtenances shall be new and unused, and shall be of the types and materials specified, as indicated or as directed.

D. The interior of pipe and fittings shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations.

E. Piping, valves, sleeves and other appurtenances shall be constructed in dry trenches and shall not be laid when the conditions of the trench or the weather is unsuitable for such work.

F. The trench bottom and bedding shall be shaped and compacted to give substantially uniform unyielding circumferential support to the lower fourth of the full length of each pipe.

G. Holes for the bells shall be excavated so that after placement the pipe and coupling receives uniform bearing pressure from the trench bottom.

H. Each pipe shall be laid to the line and grade and in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. Joint deflections are limited to 80% of the values specified in AWWA C600-99 Table 3 and 4.

I. As the work progresses, the interior and exterior of the pipes and couplings shall be cleaned of all dirt and superfluous material of every description. Any damage to bituminous coating shall be repaired prior to backfill.

J. When required to keep interior of pipe clean, a suitable drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed.

K. At times when work is not in progress, open ends of pipe and fittings shall be securely closed with a watertight plug so that no trench water, earth or other substance will enter the pipe or fitting.

L. Any pipe, valve, sleeve, or appurtenance that has been disturbed after laying shall be taken up and re-laid.

M. All materials found to be defective during the progress of the work will be rejected by the Engineer and the Contractor shall promptly remove such defective material from the site of the work and replace with new material at no additional expense to the Owner.

N. The Contractor shall be responsible for the safe storage and proper handling of all materials.

O. No shims or mounds of earth shall be used to raise the pipe to grade.

P. All pipes, valves, sleeves, and appurtenances shall be maintained accurately to the required line and grade.

Q. No pipe, valves, sleeves, and appurtenances shall be covered until the City of Beverly has inspected the joints.

R. The pipeline shall not be used to convey trench drainage during construction.

S. Pipes shall be protected at all times during construction against flotation. They shall be thoroughly secured, properly supported and bedded to prevent settlement or disturbance. Compaction of bedding and backfill material shall be in strict accordance with Section 31 00 00 - EARTHWORK.

T. Bends, crosses, tees, caps, plugs, valves, and other appurtenances shall be strapped and clamped where indicated. Steel bars, rods and plates shall be of structural steel. Straps, bridle rods, clamps, anchors and such other parts shall be provided to the details. After installation, all parts of the strapping and clamping devices shall be given two (2) heavy coats of an approved coal-tar base protective coating.

U. All lumps, burrs, excessive coatings, and irregularities on the plain and socket ends of the pipe, valves, sleeves, and appurtenances shall be removed.

V. Field cutting of the pipe is to be square and free of any burrs and defects.

W. Water shall be laid with a minimum horizontal separation of 5’ from all utilities and 10’ from sewer lines. Sewer lines crossing over water lines shall be sleeved for 10 feet on either side of crossing regardless of vertical separation distance. Sewer lines crossing under water lines shall be constructed with a minimum vertical separation of 18” or the sewer shall be constructed of ductile iron or encased in concrete for 10 feet on either side of crossing.

X. Bury piping with depth of cover over top at least 54 inches.

Y. Connect to water-supply source and construct water-service piping to a point 5 feet from the outside face of the building wall in locations and pipe sizes indicated on Drawings. It is the responsibility of the plumber to construct the required piping from this point through the building wall.

Z. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

AA. Valves shall be set in the pipeline as directed. Blocking or supports of a permanent nature shall be placed under each valve to ensure against settlement.

BB. Each valve shall be tightly closed before being placed in the line and shall remain so until the joints on each side are completely tightened.

CC. General:

1. All tapping sleeves, valves and accessories shall be carefully inspected by the contractor for defects before installation and all defective, unsound or damaged materials shall be rejected.
2. The Owner will make such additional inspections as he deems necessary and the Contractor shall furnish all necessary assistance for such inspection.
3. Proper implements, tools and facilities satisfactory to the Owner shall be provided by the Contractor for the proper and satisfactory execution of the work.

DD. All work shall be completed in conformance with the City of Beverly requirements.

EE. Tapping sleeves and valves shall be constructed in dry trenches and shall not be laid when the conditions of the trench or the weather is unsuitable for such work.

FF. Tapping sleeves, valves and couplings shall be laid to the line and grade in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line.

GG. Any tapping sleeves or valves that have been disturbed after laying shall be taken up and relayed.

HH. All materials found to be defective during the progress of the work will be rejected by the Owner and the Contractor shall promptly remove such defective material from the site of the work and replace with new material at no additional expense to the Owner.

II. The Contractor shall be responsible for the safe storage and proper handling of all materials.

JJ. Tapping sleeves shall be installed where indicated or as directed by the Owner and shall be installed according to the manufacturer's recommended procedures.

KK. Valves and joint restraints shall be installed where indicated or as directed by the Owner and shall be installed according to the manufacturer’s recommended procedures.

3.3 INSPECTION

A. General.

1. All pipe shall be installed in accordance with AWWA C600, latest revision and manufacturer requirements, and in accordance with the City of Beverly requirements.
2. All pipe and accessories shall be carefully inspected by the Contractor for defects before installation and all defective unsound or damaged materials shall be rejected.
3. The Engineer will make such additional inspections as he deems necessary and the Contractor shall furnish all necessary assistance for such inspection.
4. Proper implements, tools, and facilities satisfactory to the Engineer shall be provided by the Contractor for the proper and satisfactory execution of the work.
5. The workmanship, materials, and installation are subject to inspection and approval by City of Beverly authorized field staff. No installation shall be backfilled prior to inspection.
6. The City of Beverly reserves the right to stop work on any water main installation for failure to abide by City of Beverly standards until deficiencies are corrected.

3.4 JOINTING

A. No pipes shall be jointed until couplings and ends of pipe have been inspected to determine that the joint surfaces are free from any defects in materials or workmanship, and free from dirt or other foreign matter.

B. Pipe, pipe fittings and accessories shall be stored, installed, joined and protected by the Contractor in strict accordance with the printed recommendations of the manufacturer of the piping material.

C. Field assembled joints shall be checked with a suitable gauge as recommended by the manufacturer to ensure that the rubber rings are properly located.

D. If inspection indicates that the rings are improperly located, the Contractor shall disassemble, and properly reinstall the pipe.

E. Pipe stoppers shall be installed, sealed and blocked in such a manner as to prevent any leakage and so as to withstand an internal hydrostatic pressure of not less than 5 psi.

1. Timber blocking shall be of adequate size and arrangement to prevent the stopper from being blown off the line.
2. Timber bracing shall extend back to the undisturbed end of the trench.

3.5 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

3.6 RECORD DRAWINGS

A. All installed underground utilities shall be designated on as-built drawings by the contractor of record and provided to the Owner and Architect in AutoCadd electrical format prior to completion of the project. All as-built drawings, (underground and above ground) shall be dimensioned from permanent benchmarks such as existing buildings and include depths at various points throughout the extent of the work, and invert elevations at all structures.

3.7 SETTING VALVES AND VALVE BOXES

A. Valves shall be set in the pipelines as directed. Blocking or supports of a permanent nature shall be placed under each valve to ensure against settlement.

B. Maximum spacing between valves shall be 600 feet.

C. Each valve shall be tightly closed before being placed in the line and shall remain so until the joints on each side are completely tightened.

D. Valve boxes shall be set for all valves. They shall be carefully fitted together and to the valve and securely held during backfilling. They shall be centered over the valve-operating nut. The bedding material around them shall be thoroughly tamped in placed and the box cover set to the finished grade.

3.8 TESTING

A. Alignment Tests: Each section of pipe will be checked by the Owner or the Engineer in order to determine whether any displacement of the pipe has occurred. The Contractor shall provide suitable assistance to the Owner or the Engineer. The Contractor shall repair any poor alignment, displaced pipe or other defects discovered, as directed by the Engineer.

B. Hydrostatic Tests: After the pipe has been laid and the trench has been backfilled, all newly laid pipe or any valve section thereof, shall be subjected to a pressure and leakage test in accordance with AWWA C600-latest edition and as approved by the Engineer. The Contractor shall provide all pumps, pipe, connections, gages, measuring devices, and all other apparatus necessary for the test and shall conduct the test in the presence of and to the satisfaction of the Engineer. The Owner will supply water to the Contractor for testing purposes at no expense to the Contractor.

1. Test Pressure - The required minimum test pressure shall be 1-1/2 times the working pressure measured at the point of lowest elevation of the pipeline and corrected to the elevation of the test gage, but shall not be less than 150 psi. Test pressures shall not vary by more than plus or minus 5 psi for the duration of the test.
2. Duration of Test - two (2) hours minimum.
3. Air Removal - Prior to performance of the test the pipeline shall be completely filled with water for a period of 72 hours. Expel air by means of air relief valves, hydrants or other means as required. If permanent air vents or taps are not located at all high points, the Contractor shall install corporation stops at such points so air can be expelled. After the tests are completed, plug all temporary taps.
4. Allowable Leakage:
   a. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valve section thereof, to maintain pressure within

5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

b. No pipe installation will be accepted if the leakage is greater than that determined by the following formula in which "L" is the allowable leakage in gallons per hour; "S" is the length of pipe tested in feet; "P" is the average test pressure during the leakage test in pounds per square inch (gauge); and "D" as the nominal diameter of the pipe in inches.

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

5. Repair of Leaks - If the test discloses leakage greater than the allowable leakage the Contractor shall, at his own expense, locate and repair the defective joints until leakage is within the specified allowable. The Contractor shall repair any specific leaks regardless of the test results if, in the opinion of the Engineer, they are serious enough to endanger the future serviceability of the pipeline.

C. All materials found to be defective during testing shall be replaced with new and approved material at no additional expense to the Owner.

3.9 DISINFECTION OF POTABLE WATER LINES

A. General:

1. Flushing and disinfections of potable waterlines shall be done in accordance with the procedure set forth in AWWA C651 - Disinfecting Water Mains, latest edition, and shall be witnessed by the Engineer unless otherwise approved. The Contractor shall provide all temporary blowoffs, pumps, chlorination equipment, chlorine and all other necessary apparatus required. The Owner will supply water to the Contractor for disinfection purposes at no expense to the Contractor.
2. All valves on the new piping shall be operated during the disinfection procedure in order to ensure complete disinfections.
3. The form of chlorine proposed by the Contractor for disinfection shall be approved by the Engineer.
4. The Contractor shall take adequate measures to prevent backflow of flushing water and chlorinated water into the existing water distribution system.
5. Contractor shall not make physical connection to the existing water main prior to satisfactory results of chlorination. An approved backflow prevention device shall be utilized to transfer water from the existing system to the new piping network.

B. Pipe Cleaning:

1. If the pipe contains dirt or heavy encrusted matter that, in the opinion of the Engineer, will not be removed during the flushing operation, the Contractor shall clean and swab the interior of the pipe with a one (1) percent hypochlorite disinfecting solution.
2. The pipeline shall be flushed to remove all remaining foreign material prior to disinfections, except when the tablet method is used. The flushing operation shall develop a minimum velocity of 2.5 ft/sec. It will be the Contractor's responsibility to properly size and locate corporations within test sections to adequately flush all piping at least 2 times its volume at the desired velocity.

3. Main line valves shall not be utilized to fill, flush, test or chlorinate water mains unless authorized and supervised by the Engineer.

C. Chlorine Application:
   1. In general, chlorine shall be applied using the continuous feed method, as specified in AWWA C651.
   2. Introduce water into the line at a constant rate while adding chlorine to the water at a constant rate, such that the water will have not less than 25 mg/L free chlorine. Maintain the chlorinated water in the pipeline for a minimum of 24 hours, after which period the treated water shall have a free chlorine residual of not less than 10 mg/L throughout the entire length. Repeat the above procedure if the residual, at the end of the 24 hours, fails to meet the minimum concentration. Chlorinated water, above the normal system prevailing concentration, shall not be allowed to remain in the pipeline for a period longer than 5 days.
   3. Fire hydrants may not be used for sampling points but may be utilized as a feed source if properly flushed and the Owner's required temporary piping system installed.

D. Final Flushing:
   1. After the required retention period, flush all heavily chlorinated water from the main until the chlorine concentration is no higher than that prevailing in the system, or is acceptable for domestic use. The Contractor shall be responsible for satisfactory disposal of all flushing water and chlorinated water at no additional expense to the Owner.
   2. Prior to discharging, a reducing agent shall be applied to the water to be wasted, to neutralize thoroughly the chlorine residual remaining in the water. (See Appendix B of AWWA C651 for neutralizing chemicals.)

E. Analytical Tests:
   1. After completion of the final flushing and prior to placing the pipeline in service, two (2) consecutive sets of acceptable samples taken at least 24 hours apart shall be collected. Each sample shall be analyzed for total coliforms. All samples shall be collected by a qualified individual and will be witnessed by the Engineer, who will be given the opportunity to split all samples.
   2. All samples shall be collected in laboratory-provided glassware with appropriate preservatives. The laboratory used for testing shall be certified in the Commonwealth of Massachusetts.
   3. Sampling locations shall be subject to approval by Engineer and MassDEP.
   4. The results of the sampling and analysis shall be reported to Owner and Engineer.

F. Repetition of Procedure - If the original disinfection fails to produce satisfactory bacteriological samples, repeat the disinfection procedure until satisfactory results are obtained at no additional expense to the Owner.

3.10 TEST REPORTS AND CERTIFICATES

A. In addition to other requirements specified herein, the Contractor shall furnish to the Owner notarized test reports and methods of test by an approved independent testing laboratory to show compliance of all materials furnished under this Section of the Specifications with all the requirements herein.

B. Each shipment of pipe, tapping sleeves, valves, and appurtenances shall be accompanied by the manufacturer's notarized certificate of conformance certifying that materials to be furnished under these items meet all requirements herein.

C. All testing of materials furnished under this Section of the Specifications shall be provided by the Contractor at no additional expense to the Owner.

End of Section

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Section 33 30 01

SANITARY SEWERAGE

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 REFERENCES

A. All work specified in this Section shall conform to the standard requirements of the City of Beverly and the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as “State Standards” Specifically Section 200, 230, and 140.

B. All sanitary sewers and appurtenances shall be designed and constructed in accordance with TR-16, “Design and Construction of Sanitary and Storm Sewers” as prepared by the Technical Advisory Board of the New England Interstate Water Pollution Control Commission.

C. All work shall conform to the following standards

1. ASTM D 3034 Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
2. ASTM D 3212 Joints for Sewer Pipes using Flexible Elastomeric Seals Federal Specification.
3. SS-S-210 Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.
4. ASTM C 923 Standard Specification for resilient connectors between reinforced concrete manhole structures, pipes, and laterals.

D. All work shall be performed in accordance with the requirements of the Commonwealth of Massachusetts Department of Environmental Protection sanitary sewer requirements. Fines resulting from not conforming to the requirements shall be paid by the Contractor and at no additional expense to the Owner.

1.3 SUMMARY

A. This Section includes gravity-flow, non-pressure and pressurized sanitary sewerage outside the buildings, with the following components:
1. Manholes
2. SDR-35 PVC Gravity Sewer Pipe
3. Cleanouts

1.4 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. SDR: Standard Dimension Ratio

1.5 PERFORMANCE REQUIREMENTS

A. Pipe used for gravity flow sanitary sewers shall be SDR-35 PVC unless specified otherwise on the Drawings.

1.6 SUBMITTALS

A. Provide Shop Drawings for the following:

1. Pipe: Include specifications on pipe materials, dimensions, fittings and joint details, construction details, tolerance and physical characteristics.
2. Manholes: Include plans, elevations, Sections, details of structures, frames, and covers. Include design calculations, reinforcement product information, and concrete design-mix report.
3. Rubber Boot Connections: Provide product specifications, materials, manufacturer's information, and recommended installation procedure.
4. Cleanouts: Include frame and covers specifications and loading criteria.
5. Pump Station (see specification Section 323216 Sanitary Sewer Lift Station, Piping, and Related Equipment).

B. Conformance Certificates: Each shipment of castings, pipe, pipe fittings, and appurtenances, shall be accompanied by the manufacturer's notarized certification and cylinder testing that materials meet specified requirements.

C. Guarantee: The Contractor shall furnish to the Architect a written guarantee signed by the manufacturer of the pipe and pipe fittings which he proposes to furnish, which shall warrant and guarantee that the pipe and pipe fittings meet all requirements of the specifications and that the pipe and fittings shall not fail or be injured as a result of conveying sewage, drainage, industrial wastes or groundwater. The form of guarantee shall, in all respects, be satisfactory to the Architect.

D. Permits

1. Provide Architect and Owner's Representative with copy of all permits required prior to commencing work.

E. Field quality-control test reports for field manhole and pipe testing.

F. Record Drawings (see specification Section 029500 Site As-built Survey).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pipe on flat surface which provides even support for the pipe barrel with bell ends overhanging. Do not stack pipe higher than 5 feet. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Deliveries shall be scheduled so that the progress of the work is at no time delayed and so that large quantities of products shall not be stored for excessive lengths of time in crowded locations or in locations where large storage areas might be considered objectionable.

D. Avoid damage to pipe from impact, bending, compression or abrasion during handling and storage.

E. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct rays of the sun.

F. Use only nylon-protected slings to handle pipe. The use of hooks or bare cables will not be permitted.

G. The Contractor shall dispose of pipe damaged during delivery, handling, or storage and replace at no cost to the Owner.

H. Handle manholes according to manufacturer's written rigging instructions.

I. Use all means necessary to protect precast concrete units and materials before, during, and after installation and to protect the installed work and materials for all other trades.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewage Service: Do not interrupt service to facilities occupied by Owner or others anytime. Contractor is responsible for temporary connections from the existing high school and existing middle school to the storage tanks of the wastewater treatment plant. Contractor is responsible for the disposal of all sanitary waste collected in the tanks throughout construction. Disposal by pumping and trucking will be required until the wastewater treatment plant is online.

B. Sewer connections from the existing high school and middle school school will be phased and some proposed connections will be temporary. The existing high school will be in-use during portions of this Contract and the Contractor is responsible for proper function of all wastewater systems throughout the duration of the Contract unless otherwise specified.

C. Provide bypass system to maintain service to Owner's facility at no additional expense to the Owner.

1. All equipment and materials required to construct bypass system shall be purchased at the Contractor's expense.

D. TEMPORARY COLLECTION AND DISPOSAL OF SANITARY WASTE

1. See specification Section 33 30 00 for further description on temporary control, collection, and disposal of sanitary waste from existing facilities.

1.9 PERMITS

A. The Contractor shall obtain any permits required by the local authority prior to commencing with work affecting the sanitary sewer system.

B. No work shall commence until the Contractor has acquired all required permits and receives authorization from the Owner.

C. All required permits shall be obtained by the Contractor at no additional expense to the Owner.

1.10 MARKINGS

A. Mark pipe with the following information applied at intervals of not more than 5 feet:
   1. Manufacturer's name or trademark.
   2. Nominal pipe size;
   3. Pipe classification;
   4. Applicable dimension ratio;
   5. Date and location of manufacturer;
   6. Applicable standard designation number.

PART 2 – PRODUCTS

2.1 IDENTIFICATION

A. Underground-Type Line Markers for Non-Metallic Pipelines: Manufacturer's standard permanent detection tape, bright-colored, continuous printed polyethylene tape with a metallic core for detection of non-metallic underground installations, intended for direct-burial service; not less than 6" wide x 4 mils. thick. Provide green detection tape with black printing reading "CAUTION SEWER LINE BURIED BELOW."

2.2 POLYVINYL CHLORIDE GRAVITY SEWER PIPE

A. PVC sewer pipe for gravity sewers and service connections shall conform to ASTM D 1784 and D-3034-SDR 35 with a minimum stiffness of 46 pounds per square inch, and shall meet the following specific requirements and exceptions:
   1. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusion or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density and other physical properties.
   2. Joints shall be bell and spigot. The bell shall consist of an integral wall Section with a solid cross Section rubber ring gasket factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 3212.
   3. All fittings and accessories shall have dimensions as recommended by the manufacturer and have bell and/or spigot configurations compatible with that of the pipe. Fittings and accessories shall have integral wall Section with a solid cross Section rubber ring set in place to prevent dislocation.
   4. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.
   5. The normal length of 12-inch size and smaller pipe shall be 12.5 feet and 15-inch size shall be no longer than 20 feet.
   6. Pipe and fittings shall be manufactured in the United States of America and shall be accompanied by the manufacturer's certificate of compliance, in addition to meeting the performance tests specified hereinafter.
   7. If requested by the Architect, six specimen lengths each 6-inches long of each size pipe shall be furnished by the Contractor for impact resistance test and three specimen lengths each 6-inches long of each size pipe for pipe stiffness test. These tests are to be made in accordance with ASTM D 2444 and ASTM D 2412, respectively, at the expense of the Contractor. No pipe shall be accepted if the tests do not meet the test requirements.

2.3 NONPRESSURE-TYPE PIPE COUPLINGS

A. Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end as manufactured by Fernco. Inc or equivalent.

2.4 POLYVINYL CHLORIDE PRESSURIZED SEWER FORCE MAIN PIPE

A. All force main pipe shall conform to ASTM D2241.

B. The pipe shall be homogenous throughout and free of cracks, holes, foreign inclusion, or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density, and other physical properties.

C. Joints shall be bell and spigot. The bell shall consist of an integral wall section with a solid cross section rubber ring factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 1869 and F 477.

D. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.

E. All fittings and accessories shall have dimensions as recommended by the manufacturer. All fittings shall be ductile iron mechanical joint with gasket compatible for SDR-21 PVC pipe

2.5 CLEANOUTS:

A. Force Main Pressure Cleanouts: Force Main cleanouts and valves shall be ductile iron as shown on the Drawings, and conform to the specification Section 02510 Water Distribution.

B. Gravity Sewer Cleanouts: PVC body with PVC threaded cap and cast-iron frame and cover. Include cast-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Frame and cover shall be Cast-Iron and shall be able to withstand H20-44 loading criteria.

2.6 MANHOLE MATERIALS:

A. Cement shall be Portland cement conforming to ASTM C150, Type III, high early strength.

B. Aggregate shall conform to ASTM C330 and shall be graded, crushed stone with a resulting unit weight of concrete of up to one hundred fifty five (155) pounds per cubic foot, and a minimum unit weight of not less than one hundred forty-eight (148) pounds.

C. Water shall be clear and free of injurious and deleterious substances.

D. Concrete: shall have a minimum strength of 4000 psi at twenty eight (28) days and a strength of 2400 psi at seven (7) days.

1. During the process of manufacturing of the units not less than two (2) test cylinders shall be tested at time release of the form and two (2) at age twenty-eight (28) days.

2. All compression test cylinders shall be made, cured and stored in accordance with ASTM C31. Cylinders shall be tested in accordance with ASTM C39.
3. All concrete shall be air entrained as specified per RIDOT Standard Specifications.

E. Admixtures shall only be used after prior approval of the Owner's Representative.

F. All reinforcing bars shall conform to the requirements of ASTM designation: A615, Grade 60.

G. Welded wire fabric shall conform to the requirements of ASTM designation: A185.

2.7 PRECAST CONCRETE MANHOLES, AND BRICK:

A. Precast Concrete Manhole sections shall be equal to that shown on the drawings and shall conform to ASTM Specifications C-478 and C-76 Class IV Wall "B". The horizontal joints between sections shall be sealed using a flexible butyl resin sealant and shall conform to Federal Specifications SS-S-210A and AASHTO M-198B. In addition, the horizontal joints on the inside and outside of the manhole and catch basin shall be sealed with a "Quick Plug" as manufactured by Parson or approved equivalent.

B. Brick shall conform to ASTM Specification C-32 for sewer brick, except that the table therein is amended to provide that the required minimum compressive strength in pounds per square inch shall be for any individual brick 3,000 or 5,000 for the average of five bricks selected at random. The maximum absorption of water by five-hour boiling test shall not exceed 16% for any individual brick or 12% for the average of any five bricks selected at random.

C. Unless otherwise noted on the Drawings, sanitary manholes less than or equal to ten (10) feet deep shall have an interior diameter of 48 inches. Manholes greater than ten (10) feet shall have an interior diameter of 60 inches unless otherwise noted. All manholes with interior drops shall have an interior diameter of 60 inches unless otherwise noted. Manholes with a depth greater than 12 feet shall have an interior diameter of 72 inches unless otherwise noted.

D. Openings for pipe insertions shall be round and shall be precast or cored only. The diameter of the opening shall be adequate to install a rubber boot seal. The cored or precast opening shall maintain a minimum undisturbed distance of 6" from manhole section joints. Flexible rubber boot shall be neoprene with stainless steel clamps and bands.

2.8 MANHOLE FRAMES AND COVERS

A. Manhole Frames and Covers shall be cast iron and conform to the details on the drawings. Cast iron shall conform to ASTM A-48, Class 30. The underside of the cover and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and covers shall be machined to prevent covers from rocking in the frames under traffic.

B. Frame and covers shall be capable of withstanding H-20 highway loading.

C. Covers shall bear evenly in the frame and both frame seats and covers shall be accurately fabricated so that covers are interchangeable for use with any and all frames. Where indicated, frames and covers shall be watertight, and locked. The

sizes and weights (medium duty, heavy duty) are shown on the detail sheets for special manholes.

D. Mortar shall consist of one part cement and two parts clean sand. No lime shall be used.

E. Covers shall have a non-slip surface and shall have the word “SEWER” inscribed.

F. Frames and covers shall be installed on the manholes as indicated on the drawings. They shall be well bedded and encased in cement mortar and accurately set to the grades indicated or as directed. Red clay brick with cement mortar shall be used to adjust grade of frame and cover. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

2.9 MANHOLE STEPS

A. Manhole steps shall be manufactured of Copolymer Polypropylene plastic with ½” grade 50 steel reinforcement.

B. Steps shall conform to ASTM C-478 and Fed. Spec. FS RR-F-621.

C. The capacity of each step shall be 1000 lb. at 6-inch distance from wall and 1500 lb. at 4-inch distance from wall.

D. Steps shall measure 12 inches wide (min.) and extend 5 1/8 inches from wall.

E. Manhole steps shall be provided in each base, riser and top Section and shall be integrally cast in each; 12 inches O.C.

2.10 WATER PROOFING FOR UNDERGROUND STRUCTURES

A. Bitumastic asphalt shall conform to ASTM D449, Type A.

2.11 RUBBER BOOT

A. Rubber boot shall comply with ASTM C 923.

2.12 THRUST RESTRAINT:

A. Thrust restraint shall be provided for all bends, endcaps and changes in direction on the pressure sewer. Concrete thrust blocks shall be utilized for thrust restraint.

B. The bearing strength area of soil shall be sufficient to support 1½ times the anticipated working pressure in the pipeline but not less than 200 psi.

C. Thrust blocks shall be installed against undisturbed soil.

PART 3 - EXECUTION

3.1 GENERAL

A. At no time shall the installed sanitary sewer piping be used to convey stormwater from dewatering operations or runoff.

B. Excavating, trenching, and backfilling are specified in Section 310000 - EARTHWORK.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. All lines, grades, measurements, layout staking and reference staking necessary for the proper location and satisfactory completion of the pipeline, appurtenances and other construction, shall be the responsibility of the Contractor.

C. All stakes, references and batter boards including original, additional or replacement, which may be required for the construction operations, shall be furnished, set and properly referenced by the Contractor. The Contractor shall be solely and completely responsible for the accuracy of the line and grade of all features of the work. Any errors or apparent discrepancies found in previous surveys, plans, specifications or special provisions shall be called to the Architect's attention by the Contractor for correction or interpretation prior to proceeding with the work.

D. Upon request of the Architect, the Contractor shall furnish copies of all data used in setting and referencing all stakes and other layout markings used by the Contractor.

E. Gravity-Flow and Force Main Pressure Piping shall use the following pipe materials as applicable: Use the following pipe materials as specified on the Drawings:

1. SDR 35, sewer pipe and fittings; gaskets; and gasketed joints (used for gravity sewer).
2. SDR 21, sewer pipe and fittings, gasket joints, and factory specific lubricant. (used for force main).

F. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

G. Install gravity-flow, non-pressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, to the slope indicated on the Drawings. An even alignment of the pipe shall be maintained.
2. Install piping with 36-inch minimum cover unless specified otherwise on the Drawings
3. The Contractor shall excavate around the bell portion of the pipe so the pipe barrel bears on the prepared bed.
4. Blocking is not permitted.
5. All pipes shall be clean and free of dirt before laying and open ends shall be kept covered and free of dirt during construction.
6. The work shall be conducted in such a manner that no loose excavation or other foreign material can enter the pipes.
7. Each pipe shall be held firmly in position by carefully and thoroughly tamping backfill material around the barrel of the pipe.
8. Where new pipes are to adjoin existing structures, extreme care shall be taken in coring into existing structure. Tight waterproof connections shall be made without interrupting service.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

I. Where installing pipe below standing water table trench shall be dry and free of water and pipe bedding. Below bottom of pipe can be replaced with 1 ½" crushed stone.

J. Install force main, pressurized piping according to the following:

1. Set ring in groove. Ring shall be faced in proper direction, with color marking faced out. Smooth ring so that it seats evenly all around in the groove and is free from twists.
2. Apply only manufacturer's specified lubricant to the entire circumference of the pipe end including the bevel and 2" back from the pipe end. The coating should be about the thickness of a brush coat of enamel paint.
3. Push lubricated pipe end straight into the bell to stop mark. Any undue resistance during assembly indicates the ring may be twisted. In this case the joint should be pulled apart and reassembled.
4. Provide for pipe expansion by having the stop mark flush with the end of the bell. Care shall be taken to prevent joints already assembled in line from closing up.
5. In cutting pipe, a square cut is essential to insure ease of assembly. Use either a tubing cutter or a miter box or fine tooth carpenter's saw. The end shall be beveled to the correct taper both in angle and length. Use a factory finished beveled end as a guide.
6. Minimum cover over force main piping shall be 4'-0".
7. All fittings and bends in the pipeline shall be backed up with Class "B" Concrete thrust blocks.
8. All open ends of pipe shall be tightly closed at the end of each day.

K. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place watertight plug in end of incomplete piping at end of day and when work stops.

L. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and fitting shall be laid accurately to the required lines and grades using laser beam techniques and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed to permit making the joints. The pipe shall be bedded and backfilled in accordance with the details. Additionally, installation of the sanitary sewer below the water table may be expected and the installation of pumps, wells, or other work required to lower the water table to install sanitary sewer piping or structures shall be completed at no additional cost to the Owner.

M. The bell and rubber ring must be clean with no foreign material that could interfere with the proper assembly of the pipe spigot.

N. The pipe end must be clean. Wipe with a clean, dry cloth around the entire circumference from the end to one inch beyond the reference mark.

O. Lubricate the spigot end of the pipe, using only the factory specified lubricant supplied. Be sure to cover the entire spigot end circumference. The coating should be the equivalent of a brush coat of enamel paint. It can be applied by hand, cloth, pad, sponge, or glove.

P. Insert the spigot end into the bell so that it is in contact with the rubber ring. Keep the pipe lengths in proper alignment. Brace the bell while the spigot end is pushed in under the rubber ring, so that previously completed joints in the line will not be closed up. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell.

Q. Pipe may be easily assembled by hand and/or bar and block. Stabbing is not allowed and shall be avoided. The Contractor shall not push on the end of the pipe with a machine.

R. When the pipe laying is not in progress, the pipe shall be protected in such a way to prevent flotation. Any pipe, which has floated shall be removed from the trench and re-laid to the satisfaction of the Owner's Representative at the Contractor's expense.

S. The Contractor shall install piping as specified to within 5 feet of the building foundation. The Plumbing Contractor shall make the connection to the sanitary sewer from this point.

T. Where installing pipe below standing water table the trench shall be dry and free of water and pipe bedding. Trenching below bottom of pipe can be replaced with 1 ½" crushed stone.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints and manufacturer's recommendations.

B. Machinery shall not be used to push the pipe into place. The pipe shall be pushed into place by hand. The use of a hammer or mallet is permitted, with the use of a board to shield the end of the pipe being struck by the hammer. The pipe shall not be directly contacted with a hammer or mallet.

3.4 MANHOLES

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Form continuous concrete or brick channels and benches between inlets and outlet as specified on Drawings.

C. Install precast concrete manhole sections with sealants according to ASTM C 891.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

E. Inverts: Where pipe alignment permits, and where directed by the Architect, the pipe shall be continued through the manhole and the top half carefully and evenly cut away. Where changes in alignment occur, unless otherwise authorized by the Architect, inverts shall be constructed of brick and mortar with a smooth flow line and an even curve in accordance with the plans.

F. Joints: Pipe joints into manholes shall be constructed in accordance with the details shown on the plans. Complete details of the boot manufacture and installation shall be submitted for approval. All areas around pipes passing through walls of manholes and catch basins shall be completely filled with waterproof cement mortar to tightly fill any space through which water can pass.

G. Bricks shall be laid in a workmanlike manner, true to line, and the joints shall be carefully struck and pointed on the inside. Bricks shall be thoroughly wet when laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The outside of the brickwork shall be neatly plastered with ½" layer of cement mortar as the work progresses. The brickwork shall be satisfactorily bonded to the concrete and cast iron frame. No brick masonry shall be laid in water, or any water allowed to rise on the brickwork until the masonry has set for at least 24 hours.

H. Rubber Boot: Connections shall be installed in accordance with the manufacturer's recommendation. The connection must pass the testing procedure described below.

I. Waterproofing: All exterior surfaces of underground manholes shall receive one coat of bitumastic asphalt waterproofing.

3.5 IDENTIFICATION

A. Materials and their installation are specified in Section 310000 - Earthwork. Arrange for installation of detectable green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over all piping and over edges of underground manholes.

3.6 FIELD QUALITY CONTROL

A. Testing shall be completed in accordance with the City of Beverly requirements. At a minimum, the testing procedures below shall be completed.

B. Contract the Owner's Representative a minimum of 72 hours prior to testing. Provide results to Owner's Representative.

C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: To be determined by the Mandrel Test.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
2. The Contractor shall repair any defects or corrections required by the Architect.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified at no expense to the Owner.

4. Re-inspect and repeat procedure until results are satisfactory at no expense to the Owner.

D. Testing Manholes

1. All sanitary manholes affected by the work shall be vacuum tested prior to backfilling, including existing manholes to which new connections are made. A minimum waiting period of thirty days after installation is required for all testing.
2. Install vacuum tester and inflate compression band to affect a seal between the vacuum base and the new manhole, connect vacuum pump to the outlet part with the valve open, draw a vacuum of 10 inches of mercury, (HG), and close the valve.
3. The manhole shall pass the test if the vacuum remains at 10 inches of HG in a time greater than 60 seconds for a 48-inch diameter manhole, time greater than 75 seconds for 60-inch diameter manhole and time greater than 90 seconds for 72-inch diameter manhole.
4. If the manhole fails the initial test, the Contractor shall make proper repairs or replace the manhole and re-test at no additional compensation.

E. Testing Gravity Sewers

1. Low Pressure Air Test
   a. The Contractor shall, at his expense, conduct a line acceptance test. The test shall be performed according to stated procedures and in the presence of the Architect. A minimum waiting period of thirty days after installation is required for all testing. The line shall be flushed and cleaned prior to testing.
   b. All pneumatic plugs shall be seal-tested before being used in the actual test installation. One (1) length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.
   c. After a manhole-to-manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig greater than the average backpressure of any groundwater that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.
   d. After the stabilization period (3.5 psig minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "acceptable". If the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe) shall not be less than 5 minutes.
   e. If the installation fails the air test, the Contractor shall, at his expense determine the source of leakage. He shall then repair or replace all defective materials and/or workmanship to Architect's satisfaction and the pipeline shall be re-tested, all performed at no additional compensation to the Contractor.
2. Infiltration Test

a. The infiltration test shall be conducted at such time as the ground water level is at a height of not less than one foot above the top of the pipe for the full length of the Section of sewer being tested.

b. Each manhole-to-manhole reach shall be tested separately. At no time will the Contractor be allowed to test more than one manhole-to-manhole reach.

c. The Contractor shall construct such weirs or other means of measurement as shall be required and shall do such pumping as shall be necessary to enable the tests to be made satisfactorily.

d. The groundwater leakage into the pipes will be measured by the Owner or Architect after a minimum of one hour and the infiltration rate shall not exceed 50 gallons per day per mile per inch-diameter.

F. Pipe Deflection

1. Pipe provided shall be so installed that there be a maximum deflection of 5 percent determined by the Mandrel Test. Such deflection shall be computed by multiplying the amount of deflection (nominal diameter of the pipe less minimum diameter when measured) by 100 and dividing by the nominal pipe diameter.

2. The Contractor shall measure the amount of deflection by pulling a specially designed gauge assembly through the completed Section after 120 days of installation. The gauge assembly shall be in accordance with the recommendations of the pipe manufacturer and be acceptable to the Architect.

3. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem as the Architect may require without additional compensation.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

5. Leaks and loss in test pressure constitute defects that must be repaired. All repairs shall be at the expense of the Contractor.

3.7 CLEANING

A. Interior of piping and manholes shall be cleaned of dirt and superfluous material prior to acceptance of sanitary sewer.

3.8 RECORD DRAWINGS

A. All installed underground utilities shall be designated on as-built drawings by the contractor of record and provided to the Owner and Architect in AutoCad electrical format prior to completion of the project. All as-built drawings, (underground and above ground) shall be dimensioned from permanent benchmarks such as existing buildings and include depths at various points throughout the extent of the work, and invert elevations at all structures.

3.9 CLEANOUT INSTALLATION:

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use heavy-duty cleanout frames and covers capable of withstanding HS-20-44 loading criteria in all areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 12 by 12 by 8 inches deep. Top of concrete block shall be laid 3" below finished grade. Top of frame shall be set flush with finish grade.

C. Set cleanout frames and covers in bituminous concrete and concrete pavement with top of frame flush with pavement surface. Top of concrete block shall be laid at the bottom of the bituminous binder course.

3.10 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS:

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 60 inches below final grade

3.11 TESTING SEWER FORCE MAIN

A. Leakage Tests

1. The contractor shall furnish all materials and equipment, install necessary pipe plugs, install necessary temporary pipe taps and make leakage tests; water used shall be fresh potable water supplied by the Contractor.
2. Leakage tests shall be conducted by maintaining the pipe under a pressure, as measured at the point of lowest elevation, of 150 psi or 1-½ times for at least 2-hours. Care should be taken to expel all air from the pipes when filling with water.
3. The quantity of water measured to maintain the test pressure shall not exceed 0.09 gallons per inch of diameter per 24-hours per joint.

B. If the leakage exceeds this rate, the Contractor must repair, replace or relay sections of pipe and repeat the tests until satisfactory to the Owner's Representative at no additional cost to the Owner.

3.12 CLEANING:

A. Interior of piping and manholes shall be cleaned of dirt and superfluous material prior to acceptance of sanitary sewer.

End of Section

Section 33 40 00

STORM DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 WORK TO BE PERFORMED

A. Work under this Section includes furnishing all plant labor, equipment, appliances and materials, and performing all operations in connection with the construction of stormwater collection systems at the locations and to the lines and grades indicated on contract drawings and/or directed.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "Or equal" applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.2 DEFINITIONS

A. Plastic Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this section.

B. EPDM: Ethylene-propylene-diene terpolymer

1.3 REFERENCES

A. All work specified in this Section shall conform to the standard requirements to the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as "State Standards" Specifically Section 200, 230, and 140 and the Town of Beverly Standards.

B. ASTM C891, Standard Practice For Installation of Underground Pre-cast Utility Structures.

1.4 SUBMITTALS

A. Refer to SECTION 013300 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

B. The Contractor shall submit for approval, manufacturer's printed recommendations for the storage, protection, handling, installation and testing of storm water piping, fittings and appurtenances, which shall be strictly adhered to by the Contractor.

C. Manufacturer testing results indicating compliance with the specifications herein.

D. Licenses required by the municipality or state government to install storm drainage systems shall be submitted prior to the commencement of any work on the storm water collection system.

E. It is required to have the Installer maintain an experienced full-time supervisor on Project site when earthwork is in progress.

F. Submit shop drawings including plans, sections, and testing documentation for all products and calculations for underground stormwater systems and hydrodynamic separator.

1.5 DELIVERY, STORAGE AND HANDLING

A. Pipes shall be handled with care and in strict accordance with manufacturer's recommendations.

B. Materials and equipment shall be progressively delivered at the site so that there will be neither delay in the progress of the work nor an accumulation of materials that is not to be used within a reasonable time. Materials shall be so stored as to assure the preservation of their quality and fitness for the work.

C. Contractor will be responsible for unloading delivered treebox filter products.

D. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection.

E. Private property shall not be used for storage purposes without written permission of the owner or lessee, and if requested by the Architect copies of such written permission shall be furnished to him/her. All storage sites shall be restored to their original condition by the Contractor at his expense.

F. Care shall be taken during transportation of the pipe such that it is not damaged.

G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe.

H. Prevent damage to the interior and exterior walls of the pipe. Raising pipes with hooks, dropping or placing large stones against pipe, rolling over stones or sharp objects/edges and dropping pipe are prohibited. All damaged pipe and fitting shall be removed from the project site and replaced at no additional expense to the Architect.

1.6 GUARANTEE/WARRANTY

A. Material Guaranty: Before any contract is awarded, the Bidder may be required to furnish without expense to the owner complete statement of the origin, composition and manufacture of any or all materials proposed to be used in the construction of the work, together with samples, which may be subjected to the tests required by the owner to determine the quality and fitness of the material.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products as specified herein shall be new, unused and purchased specifically for this Contract.

2.2 HIGH DENSITY POLYETHYLENE PIPE (HDPE):

A. High-Density Polyethylene Pipe and fittings shall be ADS N-12 IB ST Smooth Interior Pipe, ADS N-12 IB ST High Capacity Large Diameter Pipe or approved equivalent. Joints shall be soil-tight and include a rubber gasket on the spigot end of the pipe. When installed into the bell end, the joint shall be sealed.

B. Pipe shall conform to AASHTO M294 (Type 'S') for the specified diameters and strength classes.

C. Pipe shall be rated to withstand H-20 Loading Criteria with 18" of cover.

2.3 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends.

B. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusion or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density and other physical properties.

C. Joints shall be bell and spigot. For SDR-35 PVC pipe, the bell shall consist of an integral wall section with a solid cross section rubber ring factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 3212. For SCH 40 PVC piping, joints shall be glued with PVC cement approved by the manufacturer.

D. All fittings and accessories shall have dimensions as recommended by the manufacturer and have bell and/or spigot configurations compatible with that of the pipe.

E. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.

F. The normal length of 12-inch size and smaller pipe shall be 12.5 feet.

G. Pipe and fittings shall be manufactured in the United States of America and shall be accompanied by the manufacturer's certificate of compliance, in addition to meeting the performance tests specified hereinafter.

H. PVC pipe shall be SCH 40 where pipe has less than 2 feet of cover or as indicated on the plans.

I. PVC perforated pipe shall conform to ASTM/ANSI D 2759 or ASTMF 810. Perforations shall be 5/8" holes on 5" centers.

2.4 MANHOLES, CATCH BASINS, AND CASTINGS

A. Precast concrete drainage manholes and catch basins, and castings for manhole covers, catch basin grates and frames shall be in accordance with Section 330513, Manholes and Catch Basins.

2.5 CATCH BASIN HOODS

A. All catch basin outlet pipes on new catch basins and all outlet pipes on existing catch basins shall be fitted with a catch basin hood.

2.6 OUTLET CONTROL STRUCTURES

A. Provide precast control structures, outlet structures shall conform to the dimensions shown on the plans and details and shall include a including galvanized steel bar grate fastened to the top of the unit. Outlet control structures

shall be precast concrete units designed for AASHTO HS20-44 loading, with openings as shown on the detail drawings.

2.7 STORMWATER HYDRODYNAMIC SEPERATOR

A. Acceptable suppliers may be Vortsentry Contech Stormwater Solutions, Hydroguard by Hydroworks, Downstream Defender, or approved equivalent.

B. Materials and Design

1. Concrete for precast stormwater treatment systems shall conform to ASTM C857 and C478 and meet the following additional requirements:
   a. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20 loading requirements.
   b. Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTMT C990.
   c. Cement shall be Type I, II, or III Portland cement conforming to ASTM C150.
   d. All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or other designate suitable handling strength.
   e. Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with a hydraulic cement conforming to ASTM C595M.

C. Performance

1. Each stormwater treatment system shall have treatment, sediment storage, and oil storage capacities equal to or greater than that shown on the table below. For the purpose of determining equivalency, the treatment capacity shall be defined as the flow rate at which the stormwater treatment system removes 80% of an unground silica sample having an average particle size equal to or less than 240 microns. Treatment capacity shall be additionally defined as the maximum flow rate prior to which bypass of any flow occurs. Calculations must be provided to show the below criteria are met with the shop drawing for the treatment system submitted.

Structure	Rim (ELEV)	Inv In (ELEV)	Inv Out (ELEV)	Pipe	25 year Flow (CFS)	Water Quality Flow (CFS)	WQV (CF)

2. Each stormwater treatment system shall provide documented full-scale testing that corroborates the capacities as listed in the table above and defined above. Said documentation shall include at a minimum testing for removal capabilities and sediment wash-out characteristics at the treatment capacities listed in table above.
3. Each stormwater treatment system shall have the capability of bypassing high

flow internally as well as controlling through the treatment chamber so as to avoid wash-out of previously captured pollutants under high flow conditions.

4. Each stormwater treatment system shall include a circular chamber with a tangential inlet to induce a swirling flow pattern within the treatment chamber. The outlet from the treatment chamber shall be located in the center of the chamber so as to maximize the particle flow path within the treatment system.
5. Each stormwater treatment system shall be of a hydraulic design that includes flow controls designed and certified by a professional engineer using accepted principles of fluid mechanics that raise the water surface inside the tank to a pre-determined level in order to prevent the re-entrainment of trapped floating contaminants.
6. Each stormwater treatment system shall be designed to not allow surcharge of the upstream network during dry weather conditions.
7. Each stormwater treatment system shall be contained within one concrete manhole structure.

2.8 CONCRETE VAULT SYSTEM

A. Manufacturer shall be StormTrap or approved equivalent.

B. Concrete chamber designed for AASHTO HS-20 Highway Loading Min Soil Pressure 3000 PSF.

C. The system shall be per the dimension shown on the plans.

D. The system shall be water tight.

E. Contractor shall submit calculations showing the system is not buoyant.

2.10 AREA DRAINS

A. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications.

B. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.

C. Drain basins grates in hardscaped areas shall be ADA compliant. Drain basin grates in landscaped areas shall be standard grates.

D. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

E. The grates and frames furnished for all surface drainage inlets shall be ductile iron and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting various wheel loads as specified. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05. Grates and covers shall be provided painted black.

2.11 TRENCH DRAINS

A. Acceptable products for this application include Poly drain by ABT Inc., ACO, Duraslope by NDS, or Approved Equivalent.

2.12 TREEBOX FILTERS

A. Each manufactured system shall consist of a precast concrete container together with an underdrain system, filter media, plant material, and appropriate grate landscape cover where applicable.

1. Concrete for precast unit shall conform to the following:
    a. The wall thickness shall not be less than 150mm (5”) or as shown on the dimensional drawings. In all cases, the wall thickness shall be no less than the minimum thickness required to meet loading requirements of the application.
    b. The precast concrete unit shall be cured by an approved method. The unit shall not be shipped until the concrete has attained 85% if its design compressive strength.
    c. The connections shall be provided to accept pipes of the specified size(s) and material(s).
2. Performance criteria:
    a. The media shall achieve flow rate equivalent to a minimum of 140 inches per hour and verified via third-party report.
    b. The unit shall remove 80% Total Suspended Solids (TSS) using a sil-co-sil 106 typical particle size distribution in the laboratory. Field results should show at least 80% TSS removal following either TAPE or TARP protocols.
    c. The unit shall be located to ensure that high flow events shall bypass the filter media preventing erosion and re-suspension of pollutants.

2.12 EPDM SHEET MATERIALS

A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Firestone Building Products.
    b. Raven Industries, Inc.
    c. Yunker Plastics, Inc.
2. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    a. Construction: [**9 x 9 - 1000 d**] [**10 x 10 - 1000 d**].
3. Nominal Thickness: [**45-mil-**] thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
4. Breaking Strength: Not less than [**190 lbf**] minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
5. Tear Resistance: Not less than [**130 lb**] minimum average per ASTM D 1004.

6. Puncture Strength: Not less than [**60 lbf**] minimum average per ASTM D 4833.

B. Fabrication:

1. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

C. Source Quality Control:

1. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.

2. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet or once per panel, whichever is more frequent.

3. EPDM Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. of seam width and for bonded seam strength not less than 160 lbf/in. of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils.

2.13 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

C. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

D. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material: Liner manufacturer's standard system.
2. Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
3. Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
4. Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.

PART 3 - EXECUTION

3.1 GENERAL

A. The installation of all pipes of various materials, structures, and connections to existing pipes/structures shall be made at the locations and elevations as shown on the drawings.

B. All materials and each part of detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools and equipment at no expense to Architect.)

C. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

D. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks in advance of the incorporation in the work of any such materials.

E. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

3.2 TRENCH EXCAVATION AND BACKFILL

A. Excavation and backfill of piping shall be performed as specified in Section 31 00 00, EARTHWORK.

B. Pipe bedding shall be placed as specified in Section 31 00 00, EARTHWORK.

3.3 PIPE INSTALLATION

A. Use only nylon-protected slings to handle pipe. The use of hooks or bare cables will not be permitted.

B. PVC Piping: No machinery shall directly contact the PVC pipe to push the pipe into place. The pipe shall be pushed into place by hand. The use of a hammer or mallet is permitted, with the use of a board to shield the end of the pipe being struck by the hammer. The pipe shall not be directly contacted with a hammer or mallet. Any pipe damaged while being pushed into place or while being laid in the trench shall be removed from the site and replaced at the expense of the Contractor.

C. HDPE Piping: An elastomeric rubber gasket supplied by the manufacturer shall be installed at each HDPE pipe joint to insure that each joint is silt tight.

D. Pipe shall be inspected before any backfill is placed. Any pipe determined by the Engineer to be out of alignment, unduly settled, or damaged shall be taken up and re-laid or replaced at no additional cost to Owner.

E. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground storm drainage piping. Install piping as indicated, following piping manufacturer's written instructions.

F. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

G. If conflicts between utilities, the Contractor shall stop work on the utilities, contact the Engineer, and await direction from the Engineer.

H. Install piping with 36-inch minimum cover unless otherwise specified on the Drawings.

I. Install piping with a minimum slope as specified on Drawings.

J. Install PVC piping according to ASTM D 2321, ASTM F 1668, and manufacturer's recommendations.

3.4 STORMWATER HYDRODYNAMIC SEPERATOR INSTALLATION

A. The stormwater treatment system shall be installed in strict accordance with the manufacturer's recommendations.

B. Excavation, bedding, backfill and compaction for the structure shall be as specified in Section 31 00 00, EARTHWORK.

C. The structure shall be watertight upon the completion of the installation.

3.5 CONCRETE VAULT SYSTEM INSTALLATION

A. Refer to Manufacturer's Installation Guide for proper procedure required to maintain structural integrity and functionality of the system.

3.6 AREA DRAIN INSTALLATION

A. Install Trench Drain System according to manufacturer's requirements and specifications.

B. Set tops of grating frames and grates flush with finished surface, unless otherwise indicated.

C. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures.

D. The backfill material shall be crushed stone or other granular material meeting the requirements of class 1 or class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321.

E. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height.

F. For load rated installations, a concrete slab shall be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other applicable design factors.

End of Section

APPENDIX A

KEYNOTE LIST

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DIVISION 00 - BIDDING AND CONTRACT REQUIREMENTS

00 01 01 NOT USED

00 01 01.01 NOT USED

DIVISION 01 - GENERAL REQUIREMENTS

01 00 01 NOT USED

01 00 01.01 NOT USED

DIVISION 02 - EXISTING CONDITIONS

02 00 01 NOT USED

02 00 01.01 NOT USED

DIVISION 03 - CONCRETE

03 05 13 CONCRETE SEALERS

03 05 13.01 CONCRETE SEALER
03 05 13.02 PRIMER

03 30 00 CAST-IN-PLACE CONCRETE

03 30 00.01 CONCRETE
03 30 00.02 CONCRETE SLAB ON GRADE - SEE STRUCTURAL
03 30 00.03 CONCRETE SLAB ON DECK - SEE STRUCTURAL
03 30 00.04 CONCRETE FOOTING - SEE STRUCTURAL
03 30 00.05 CONCRETE FOUNDATION - SEE STRUCTURAL
03 30 00.06 CONCRETE WALL - SEE STRUCTURAL
03 30 00.07 CONCRETE PIER - SEE STRUCTURAL
03 30 00.08 CONCRETE PAD - SEE STRUCTURAL
03 30 00.09 CONCRETE GRADE BEAM - SEE STRUCTURAL
03 30 00.11 EXPANDABLE JOINT FILLER
03 30 00.12 NORMAL WEIGHT CONCRETE - SEE STRUCTURAL

03 30 00.21 SAW CUT JOINT

03 30 00.31 REINFORCING STEEL BAR - SEE STRUCTURAL

DIVISION 04 - MASONRY

04 20 00 UNIT MASONRY

04 20 00.01 CMU - STANDARD - NORMAL WEIGHT - REFERENCE DRAWINGS FOR DEPTH SIZE AND FIRE RATING
04 20 00.02 CMU BOND BEAM - SEE STRUCTURAL

04 20 00.50 MASONRY MORTAR
04 20 00.51 GROUT FILL

04 20 00.61 TYPICAL MASONRY ANCHOR/TIES - REFERENCE SPECIFICATION FOR SPACING
04 20 00.62 HORIZONTAL MASONRY REINFORCING- GALVANIZED TRUSS TYPE
04 20 00.63 COMPRESSIBLE FILLER AT TOP OF MASONRY PARTITIONS AND EXPANSION JOINTS
04 20 00.64 SEALANT - TYPE AS REQUIRED

04 73 16 SIMULATED STONE VENEER

04 73 16.01 STONE VENEER
04 73 16.02 STONE SILL

04 73 16.10 GALVANIZED METAL LATH
04 73 16.11 SCRATCH COAT
04 73 16.12 MORTAR

DIVISION 05 - METALS

05 12 00 STRUCTURAL STEEL FRAMING

05 12 00.01 STEEL BEAM - SEE STRUCTURAL
05 12 00.02 STEEL COLUMN - SEE STRUCTURAL
05 12 00.06 STEEL TUBE - SEE STRUCTURAL
05 12 00.08 STEEL TUBE COLUMN - SEE STRUCTURAL

05 12 00.10 STEEL OUTRIGGER - SEE STRUCTURAL
05 12 00.14 STEEL TRUSS - SEE STRUCTURAL
05 12 00.16 STEEL CHANNEL - SEE STRUCTURAL
05 12 00.18 STEEL ANGLE CONTINUOUS - SEE STRUCTURAL
05 12 00.19 STEEL TUBE STRINGER - SEE STRUCTURAL

05 12 00.20 STEEL RELIEVING ANGLE - SEE STRUCTURAL

05 12 00.32 STEEL PLATE - SEE STRUCTURAL
05 12 00.36 STEEL PLATE BENT - SEE STRUCTURAL

05 12 00.40 BRACE FRAME - SEE STRUCTURAL

05 12 00.60 STEEL BENT PLATE - 5 x 15-1/2 x 5/16 - CONTINUOUS - 1/2 INCH DIA SLOTTED HOLES
@ VERTICAL LEG AT 32 INCHES O.C. - WELD TO STRUCTURAL STEEL - SEE STRUCTURAL
05 12 00.61 STEEL BENT PLATE - 5 x 20 x 3/8 - CONTINUOUS - 1/2 INCH DIA SLOTTED HOLES
@ VERTICAL LEG AT 32 INCHES O.C. - WELD TO STRUCTURAL STEEL - SEE STRUCTURAL
05 12 00.62 STEEL BENT PLATE - 5 x 10 1/2 x 3/8 - CONTINUOUS - 1/2 INCH DIA SLOTTED HOLES
@ VERTICAL LEG AT 32 INCHES O.C. - WELD TO STRUCTURAL STEEL - SEE STRUCTURAL

05 15 00 STUD SHEAR CONNECTORS

05 15 00.01 STEEL SHEAR STUD CONNECTORS - SEE STRUCTURAL

05 31 00 STEEL DECKING

05 31 00.01 COMPOSITE STEEL DECK - SEE STRUCTURAL
05 31 00.02 POUR STOP - FLOOR SLAB - SEE STRUCTURAL
05 31 00.03 STEEL FORM DECK - SEE STRUCTURAL

05 31 00.10 STEEL ROOF DECK - 1 1/2 INCH GALVANIZED - SEE STRUCTURAL
05 31 00.11 STEEL ROOF DECK - 3 INCH GALVANIZED - SEE STRUCTURAL
05 31 00.12 STEEL ROOF DECK - 1 1/2 INCH CELLULAR ACOUSTICAL DECK - SEE STRUCTURAL
05 31 00.13 STEEL ROOF DECK - 3 INCH CELLULAR ACOUSTICAL DECK - SEE STRUCTURAL

05 40 00 COLD FORMED METAL FRAMING

05 40 00.01 STEEL STUDS - 1 5/8 INCH - 16 INCHES O.C. MAX
05 40 00.02 STEEL STUDS - 2 1/2 INCH - 16 INCHES O.C. MAX
05 40 00.03 STEEL STUDS - 3 5/8 INCH - 16 INCHES O.C. MAX
05 40 00.04 STEEL STUDS - 4 INCH - 16 INCHES O.C. MAX
05 40 00.05 STEEL STUDS - 5 INCH - 16 INCHES O.C. MAX
05 40 00.06 STEEL STUDS - 6 INCH - 16 INCHES O.C. MAX
05 40 00.08 STEEL STUDS - 8 INCH - 16 INCHES O.C. MAX
05 40 00.10 STEEL STUDS - 10 INCH - 16 INCHES O.C. MAX
05 40 00.11 STEEL STUDS - 11 INCH - 16 INCHES O.C. MAX
05 40 00.12 STEEL STUDS - 12 INCH - 16 INCHES O.C. MAX

05 40 00.17 STEEL Z-CLIP - 16 INCHES O.C. MAX
05 40 00.18 STEEL Z-CLIP - 3 INCH - 16 INCHES O.C. MAX
05 40 00.19 STEEL Z-CLIP - 16 GAGE MIN. - 1 INCH MIN. DEPTH - 16 INCHES O.C. MAX

05 40 00.21 ISOLATION HANGER
05 40 00.22 NEOPRENE PAD
05 40 00.23 METAL CEILING HANGER - ENGINEERED TO SUPPORT CEILING SYSTEM

05 40 00.25 METAL FURRING - 7/8 INCH

05 40 00.40 DOUBLE STUD AT JAMB - SIZE AS REQUIRED
05 40 00.41 STEEL STUD & TRACK - BOXED HEADER
05 40 00.42 STEEL BUILT-UP COLUMN

05 40 00.55 14 GAGE BENT GALVANIZED STEEL PLATE - SECURE TO STRUCTURAL MEMBER AS REQUIRED - SIZE AS NOTED OR DRA\
05 40 00.56 LIGHT GAGE BENT PLATE - SIZE AS REQUIRED

05 40 00.60 DOUBLE STEEL STUD CLEAT - 10 INCH - CONTINUOUS
05 40 00.61 DOUBLE STEEL STUD CLEAT - 4 INCH - CONTINUOUS

05 40 00.70 STEEL TRUSS - 6 INCH

05 50 00 METAL FABRICATIONS

05 50 00.01 STEEL ANGLE - 5 x 3 x 5/16 LLV - CONTINUOUS - CURVED - 1/2 INCH DIA SLOTTED HOLES
@ VERTICAL LEG STAGGERED - HOLES @ 32 INCHES O.C.
05 50 00.02 STEEL ANGLE - 6 x 3-1/2 x 3/8 - CONTINUOUS - CURVED

05 50 00.10 STEEL ANGLE - SEISMIC CLIP - SEE STRUCTURAL
05 50 00.11 STEEL ANGLE - SUPPORT FOR ELEVATOR SILL - SIZE AS REQUIRED
05 50 00.12 STEEL ANGLE - SEE STRUCTURAL
05 50 00.13 STEEL ANGLE CONTINUOUS - SIZE AS NOTED OR DRAWN
05 50 00.14 ALUMINUM CEILING TRUSS

05 50 00.21 STEEL TUBE - SEE STRUCTURAL
05 50 00.22 STEEL BEAM - SEE STRUCTURAL

05 50 00.31 STEEL CHANNEL - ROOF OPENING - SEE STRUCTURAL
05 50 00.32 STEEL BENT PLATE - SEE STRUCTURAL

05 50 00.40 STEEL PLATE - 20 GAGE - SECURE TO EACH STUD
05 50 00.41 STEEL PLATE - 1/4 INCH THICK
05 50 00.42 STEEL PLATE - 5/16 INCH THICK
05 50 00.43 STEEL PLATE - 3/8 INCH THICK
05 50 00.44 STEEL PLATE - 1/2 INCH THICK
05 50 00.45 STEEL PLATE - 5/8 INCH THICK
05 50 00.46 STEEL PLATE - 1/4 INCH THICK, 12 INCHES IN LENGTH. COORDINATE HEIGHT OF PLATE, LOCATIONS AND QUANTITY OF P

05 50 00.51 STEEL ANGLE LINTEL - REFERENCE STRUCTURAL STEEL SCHEDULE

05 50 00.55 STEEL ANGLE - 1-1/2 INCH x 1-1/2 INCH X 4 INCH
05 50 00.56 THREADED ROD - 1/4 INCH DIA WITH WASHERS AND BOLTS - CUT ROD FLUSH TO BOLTS AND GRIND SMOOTH

05 50 00.60 SHOP APPLIED COLOR COATING

05 50 00.65 STAINLESS STEEL SUNSHADE SUPPORT BRACKET

05 50 00.70 STAINLESS STEEL CLEVIS - NUMBER 3
05 50 00.71 STAINLESS STEEL ROD - 1 INCH DIAMETER
05 50 00.72 STAINLESS STEEL PLATE - 1/2 INCH THICK
05 50 00.73 STAINLESS STEEL RING - 1/2 INCH THICK

05 50 00.75 STAINLESS STEEL MOUNTING FLANGE
05 50 00.76 STAINLESS STEEL BENT PLATE - 1/8 INCH THICK

05 50 00.80 THREADED POST - 1/4 INCH DIAMETER - WELDED TO LETTER
05 50 00.81 ANCHOR BOLT

05 50 00.91 STEEL BOLLARD - INSTALLED BY SITE CONTRACTOR
05 50 00.93 ROOF ACCESS LADDER - INTERIOR
05 50 00.94 ROOF ACCESS LADDER - EXTERIOR
05 50 00.95 ROOF ACCESS LADDER CAGE
05 50 00.96 CATWALK ACCESS LADDER - INTERIOR
05 50 00.99 SHIPS LADDER

05 51 00 METAL STAIRS AND RAILINGS

05 51 00.01 STEEL PAN TREAD AND RISER
05 51 00.02 STEEL PAN LANDING
05 51 00.03 STEEL CHANNEL STRINGER
05 51 00.04 STEEL CHANNEL HEADER
05 51 00.05 STEEL CLOSURE PLATE - WELDED AND GROUND SMOOTH
05 51 00.06 STEEL TUBE LANDING BEAM
05 51 00.07 STEEL TUBE STRINGER

05 51 00.10 STEEL ANGLE CONTINUOUS
05 51 00.11 STEEL ANGLE CLIP
05 51 00.12 STEEL ANGLE CARRIER
05 51 00.14 STEEL ANGLE 5 x 5 x 3/8 - WELD TO STEEL STRINGER
05 51 00.15 STEEL ANGLE 2 X 2 X 3/8
05 51 00.16 STEEL PLATE - 1/2 INCH
05 51 00.17 STEEL PLATE - 1/4 INCH
05 51 00.18 STEEL PLATE - 1/2 INCH - CUSTOM CUT
05 51 00.19 STEEL PLATE - 1/4 INCH - CUSTOM CUT

05 51 00.20 STEEL PIPE GUARDRAIL - 1-1/2 INCH O.D.
05 51 00.21 STEEL PIPE GUARDRAIL POST - 1-1/2 INCH O.D.
05 51 00.22 STEEL PIPE HANDRAIL - 1-1/2 INCH O.D.
05 51 00.24 STEEL HANDRAIL BRACKET
05 51 00.25 STEEL HANDRAIL POST BRACKET
05 51 00.26 STEEL POST CANOPY

05 51 00.32 STAINLESS STEEL INTERMEDIATE HANDRAIL WITH POSTS ANCHORED TO FLOOR
05 51 00.33 STAINLESS STEEL PIPE HANDRAIL - 1-1/2 INCH O.D.
05 51 00.34 STAINLESS STEEL HANDRAIL BRACKET
05 51 00.35 STAINLESS STEEL HANDRAIL POST BRACKET
05 51 00.36 STAINLESS STEEL BAR - 3/4 INCH X 2 INCH
05 51 00.37 STAINLESS STEEL BAR - 1/2 INCH X 1 1/2 INCH

05 51 00.39 STEEL BAR - 1/2 INCH x 1-1/2 INCH
05 51 00.40 STEEL BAR - 3/8 INCH x 3/8 INCH
05 51 00.41 STEEL BAR - 1/2 INCH x 1/2 INCH

05 51 00.43 STEEL TUBE - 1-1/2 INCH X 4 INCH - WITH END CLOSURE PLATES
05 51 00.44 STEEL BAR - 1 INCH X 2 INCH
05 51 00.45 STEEL BAR - 5/8 INCH x 5/8 INCH
05 51 00.46 STEEL BAR - 5/8 INCH DIA.
05 51 00.47 STEEL BAR - 5/8 INCH x 1 INCH
05 51 00.48 STEEL BAR - 1 INCH x 1 INCH
05 51 00.49 STEEL BAR - 1 INCH x 1-1/2 INCH
05 51 00.50 STEEL BAR - 1 1/2 INCH X 1 1/2 INCH

05 51 00.51 STEEL ANGLE LINTEL - REFERENCE STRUCTURAL STEEL SCHEDULE

05 51 00.60 WELD TO STEEL FRAMING
05 51 00.62 STEEL TRIANGLE SUPPORT BRACKET - 2 INCH WIDE x 1/4 INCH THICK @ 18 INCHES O.C. MAX
PREDRILLED INSTALLATION @ FASTENING HOLES

05 51 00.70 STEEL PIPE - 1.900 O.D.

05 51 00.93 STEEL PIPE RAIL POST - EXTERIOR
05 51 00.94 STEEL HANDRAIL BRACKET - EXTERIOR
05 51 00.95 STEEL BAR BALUSTER - 5/8 INCH DIA.- EXTERIOR
05 51 00.96 STEEL PIPE RAIL - 1-1/2 INCH O.D.- EXTERIOR
05 51 00.97 STEEL PIPE GUARDRAIL - 1-1/2 INCH NOM. DIA. - EXTERIOR
05 51 00.98 STEEL PIPE SLEEVE

05 51 00.99 CORE DRILL 4 INCH x 12 INCH DEEP POST PLACEMENT - GROUT SOLID TYPICAL

05 58 13 COLUMN COVER

05 58 13.01 COLUMN COVER
05 58 13.02 REVEAL INSERT - 1/2 INCH X 1/2 INCH
05 58 13.03 EXTRUDED ALUMINUM POST
05 58 13.04 FLOOR/CEILING BRACKET
05 58 13.05 COLUMN COLLAR

DIVISION 06 - WOOD PLASTICS AND COMPOSITES

06 10 00 ROUGH CARPENTRY

06 10 00.01 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - ROOF EDGE - SIZE AS NOTED OR DRAWN - STAGGER BOLTED TO ANGLE AT 32 INCHES O.C.
06 10 00.02 WOOD BLOCKING - (2X) CONTINUOUS WITH PLYWOOD SHIMS - PRESSURE TREATED - ROOF EDGE - SIZE AS NOTED OR I STAGGER BOLTED TO ANGLE AT 32 INCHES O.C.

06 10 00.04 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - SIZE AS REQUIRED - ESTABLISH LEVEL INSTALLATION SURFACE FOR ROOFTOP CURB
06 10 00.05 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - LOCKER BASE - SIZE AS NOTED OR DRAWN - BOLT IF REQ

06 10 00.11 WOOD BLOCKING - 2X PRESSURE TREATED - SIZE AS NOTED OR DRAWN
06 10 00.12 WOOD BLOCKING - 1X PRESSURE TREATED - SIZE AS NOTED OR DRAWN

06 10 00.21 WOOD BLOCKING - 2X FIRE RETARDANT TREATED - SIZE AS NOTED OR DRAWN
06 10 00.23 WOOD BLOCKING - FIRE RETARDANT TREATED - SIZE AS NOTED OR DRAWN

06 10 00.31 PLYWOOD - 1/4 INCH
06 10 00.32 PLYWOOD - 1/2 INCH
06 10 00.33 PLYWOOD - 5/8 INCH
06 10 00.34 PLYWOOD - 3/4 INCH
06 10 00.35 PLYWOOD - 3/4 INCH CONTINUOUS BETWEEN METAL STUDS - COORDINATE PLACEMENT WITH PROJECTOR SUPPORT RI
06 10 00.36 PLYWOOD - 3/8 INCH

06 10 00.41 PLYWOOD PRESSURE TREATED - 1/4 INCH
06 10 00.42 PLYWOOD PRESSURE TREATED - 1/2 INCH
06 10 00.43 PLYWOOD PRESSURE TREATED - 5/8 INCH
06 10 00.44 PLYWOOD PRESSURE TREATED - 3/4 INCH

06 10 00.51 WOOD STUD - 2X4 - 16 INCHES O.C. - SHOP WORKSTATION
06 10 00.52 WOOD STUD - 2X6 - 16 INCHES O.C. - SHOP WORKSTATION
06 10 00.53 WOOD TOP PLATE - (2) 2X4 CONTINUOUS - SHOP WORKSTATION
06 10 00.54 WOOD TOP PLATE - (2) 2X6 CONTINUOUS - SHOP WORKSTATION
06 10 00.55 WOOD SOLE PLATE - 2X4 CONTINUOUS - SHOP WORKSTATION
06 10 00.56 WOOD SOLE PLATE - 2X6 CONTINUOUS - PRESSURE TREATED - SHOP WORKSTATION
06 10 00.57 WOOD BOARD - 1X12 - SHOP WORKSTATION
06 10 00.58 WOOD CEILING JOIST - 2X12 - 16 INCHES O.C. - SHOP WORKSTATION

06 10 00.80 2X WOOD STRINGER - FIRE TREATED
06 10 00.82 2X4 PRESSURE TREATED SLEEPERS - 16 INCHES O.C.

06 10 00.90 EXPANSION BOLT
06 10 00.92 INSECT SCREEN

06 16 00 GYPSUM SHEATHING

06 16 00.01 GYPSUM EXTERIOR SHEATHING - 1/2 INCH

06 20 00 FINISH CARPENTRY

06 20 00.01 HARDWOOD MILLWORK - TRANSPARENT FINISH
06 20 00.02 HARDWOOD TRIM - TRANSPARENT FINISH
06 20 00.03 HARDWOOD TRIM - 3/4 INCH - PENCILED EDGE 1/8 INCH RADIUS - TRANSPARENT FINISH
06 20 00.04 HARDWOOD SILL - 3/4 INCH - 1/4 INCH RADIUS EASED EDGE - TRANSPARENT FINISH

06 20 00.10 PVC PANEL - 1/2 INCH THICK
06 20 00.11 PVC PANEL - 5/8 INCH THICK
06 20 00.12 PVC TRIM - 5/4x4
06 20 00.13 PVC TRIM - 5/4x6
06 20 00.14 PVC TRIM - 5/4x8
06 20 00.15 PVC TRIM - 5/4x10
06 20 00.16 PVC TRIM - SIZE AS NOTED
06 20 00.17 PVC TRIM - 1x4
06 20 00.18 PVC TRIM - 1x6
06 20 00.19 PVC TRIM - 1x8
06 20 00.20 PVC TRIM - 1x10

06 20 00.21 HARDWOOD TRIM - 1/2 INCH - TRANSPARENT FINISH
06 20 00.22 HARDWOOD TRIM - 1/4 INCH - TRANSPARENT FINISH
06 20 00.23 HARDWOOD TRIM - 3/4 INCH - TRANSPARENT FINISH
06 20 00.24 HARDWOOD TRIM - 1 INCH - TRANSPARENT FINISH
06 20 00.25 HARDWOOD SHELF 1 INCH - TRANSPARENT FINISH
06 20 00.26 HARDWOOD TRIM - 5/4 INCH - TRANSPARENT FINISH

06 20 00.29	HARDWOOD BULLNOSE - TRANSPARENT FINISH
06 20 00.31	HARDWOOD VENEER PLYWOOD - 1/2 INCH - TRANSPARENT FINISH
06 20 00.32	HARDWOOD VENEER PLYWOOD - 5/8 INCH - TRANSPARENT FINISH
06 20 00.33	HARDWOOD VENEER PLYWOOD - 3/4 INCH - TRANSPARENT FINISH
06 20 00.34	HARDWOOD EDGING ON PLYWOOD - TRANSPARENT FINISH
06 20 00.42	PLYWOOD - 1/2 INCH
06 20 00.43	PLYWOOD - 5/8 INCH
06 20 00.44	PLYWOOD - 3/4 INCH
06 20 00.45	OSB PLYWOOD - 3/4 INCH - TRANSPARENT FINISH
06 20 00.51	MDF PLYWOOD - 1/2 INCH
06 20 00.53	MDF PLYWOOD - 3/4 INCH
06 20 00.54	MDF PLYWOOD - 1 INCH
06 20 00.55	MDO PLYWOOD - 3/4 INCH
06 20 00.56	PEGBOARD - 1/4 INCH THICK
06 20 00.60	FLAG HOOK STANDOFF WITH CAP
06 20 00.61	VENTED WALL BASE
06 20 00.62	HARDBOARD STAGE FLOORING
06 20 00.63	FLATHEAD STAINLESS STEEL WOOD SCREW – COUNTERSUNK
06 20 00.64	STAINLESS STEEL DOME HEAD RIVET - DOUBLE SIDED - 7MM CAP
06 20 00.65	BRUSHED STAINLESS FINISH ALUMINUM CHANNEL - 1 INCH
06 20 00.66	CLEAT HANGER
06 20 00.67	BRUSHED STAINLESS FINISH ALUMINUM OUTSIDE CORNER TRIM - 3/8 UNCH EXPOSED FACE.
06 20 00.71	STAINLESS STEEL SCREWS - COUNTERSUNK
06 20 00.72	STAINLESS STEEL SCREWS - WITH FINISH WASHERS
06 20 00.73	STAINLESS STEEL BOLTS - NUTS AND WASHERS - 1/2 INCH DIA
06 20 00.74	STAINLESS STEEL INFILL PANEL TYPE 1
06 20 00.76	STAINLESS STEEL TURNBUCKLE
06 20 00.77	LOCK
06 20 00.78	HINGE
06 20 00.79	RECYCLING BIN - PROVIDED BY FFE
06 20 00.80	STEEL UNDER COUNTER SUPPORT BRACKET - SIZE AS NOTED OR DRAWN
06 20 00.81	PLASTIC LAMINATE COUNTER TOP
06 20 00.82	PLASTIC LAMINATE BACKSPLASH - 4 INCH
06 20 00.83	PLASTIC LAMINATE
06 20 00.84	GROMMET - 3 INCH - PLASTIC
06 20 00.85	SHELVING BRACKET
06 20 00.86	WIRE MANAGEMENT HOOKS – 12 INCHES O.C. – UNDER COUNTER
06 20 00.87	EDGE LIT GLAZING CHANNEL - COORDINATE WITH ELECTRICAL
06 20 00.88	CUP CABINET DOOR HINGES - 12 INCHES O.C. MAX
06 20 00.90	HARDWOOD TREAD AND RISER TO MATCH STAGE FLOOR - TRANSPARENT FINISH
06 20 00.91	HARDWOOD HANDRAIL - TRANSPARENT FINISH
06 20 00.97	WOOD SLEEPERS - SIZE AS REQUIRED
06 20 00.98	WOOD BLOCKING - FIRE RETARDANT TREATED - SIZE AS REQUIRED
06 20 00.99	WOOD BLOCKING - SIZE AS REQUIRED
06 40 00	**ARCHITECTURAL WOODWORK**
06 40 00.01	ADMINISTRATION CIRCULATION DESK
06 40 00.02	MAILBOX UNITS
06 40 00.03	LIBRARY CIRCULATION DESK
06 40 00.04	LIBRARY COMPUTER DESK
06 40 00.05	DISPLAY CASE
06 40 00.14	PLASTIC LAMINATE
06 40 00.15	TACKABLE SURFACE
06 40 00.16	ALUMINUM EXTRUSION TRIM - TACK WALL SURFACE
06 40 00.20	HARDWOOD TRIM - TRANSPARENT FINISH - SIZE AS DRAWN
06 40 00.21	HARDWOOD TRIM - 1/2 INCH - TRANSPARENT FINISH
06 40 00.22	HARDWOOD TRIM - 3/4 INCH - TRANSPARENT FINISH
06 40 00.23	HARDWOOD TRIM - 1 INCH - TRANSPARENT FINISH
06 40 00.25	HARDWOOD TRIM - 3/4 INCH - PENCILED EDGE 1/8 INCH RADIUS - TRANSPARENT FINISH
06 40 00.31	HARDWOOD VENEER PLYWOOD - 1/2 INCH - TRANSPARENT FINISH
06 40 00.32	HARDWOOD VENEER PLYWOOD - 3/4 INCH - TRANSPARENT FINISH
06 40 00.33	HARDWOOD VENEER PLYWOOD - 1 INCH - TRANSPARENT FINISH
06 40 00.35	HARDWOOD EDGING ON PLYWOOD - TRANSPARENT FINISH
06 40 00.41	PLYWOOD - 1/2 INCH
06 40 00.42	PLYWOOD - 3/4 INCH
06 40 00.52	HARDWOOD EDGE TRIM - TRANSPARENT FINISH
06 40 00.61	WOOD BLOCKING - 2X
06 40 00.62	WOOD BLOCKING - SIZE AS REQUIRED
06 40 00.65	BRUSHED STAINLESS FINISH ALUMINUM CHANNEL - 1 INCH

06 40 00.67 BRUSHED STAINLESS FINISH ALUMINUM OUTSIDE CORNER TRIM - 3/8 UNCH EXPOSED FACE.

06 40 00.71 LOCK
06 40 00.72 CABINET DOOR
06 40 00.73 DOUBLE ACTION SPRING HINGE
06 40 00.74 HINGE
06 40 00.75 STAINLESS STEEL BAR RAIL AND POSTS
06 40 00.77 METAL GLAZING CHANNEL
06 40 00.78 WIRE PULL
06 40 00.79 CARD HOLDER - RECTANGULAR - 1-1/8" x 3-1/8"

06 40 00.81 SLIDING GLASS DOORS - SET IN ALUMINUM TRACKS - PROVIDE LOCKS
06 40 00.82 ADJUSTABLE SHELVING STANDARDS AND BRACKETS
06 40 00.84 GLASS SHELVING AND BRACKETS

06 40 00.85 PORCELAIN ENAMEL CHALK SURFACE - SELF ADHERING - COLOR BLACK

06 40 00.96 ACCESS PANEL
06 40 00.97 3 INCH GROMMET - PLASTIC
06 40 00.98 WIRE MANAGEMENT HOOKS - 12 INCHES O.C. - UNDER COUNTER
06 40 00.99 UNDER COUNTER STEEL SUPPORT WITH PRE-DRILLED HOLES

06 55 00 SOLID SURFACING

06 55 00.01 SOLID SURFACE MATERIAL
06 55 00.02 SEALANT
06 55 00.03 PLYWOOD BACKING
06 55 00.04 ADHESIVE
06 55 00.05 Z-CLIPS SECURED TO BLOCKING AND SOLID SURFACING
06 55 00.06 GROMMET - 3 INCH - PLASTIC
06 55 00.07 STAINLESS STEEL TRASH GROMMET - 12 INCH

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 13 53 ELASTOMERIC SHEET WATERPROOFING

07 13 53.01 ADHERED VERTICAL WATERPROOFING
07 13 53.02 BELOW-SLAB HORIZONTAL WATERPROOFING

07 13 53.11 DRAINAGE COMPOSITE BOARD

07 16 13 POLYMER MODIFIED CEMENT WATERPROOFING

07 16 13.01 POLYMER MODIFIED CEMENT WATERPROOFING MATERIAL

07 21 00 THERMAL INSULATION

07 21 00.01 RIGID INSULATION - 2 INCH - FOUNDATION ONLY
07 21 00.02 RIGID INSULATION - 2 INCH - UNDER SLAB - HIGH COMPRESSIVE STRENGTH

07 21 00.11 INSULATING NAIL BASE - 2 INCH - EXTERIOR WALL

07 21 00.20 GLASS FIBER INSULATION
07 21 00.21 GLASS FIBER ACOUSTICAL BLANKET INSULATION - 6 INCH - UNFACED
07 21 00.22 GLASS FIBER ACOUSTICAL BLANKET INSULATION - 3 1/2 INCH - UNFACED

07 21 00.29 GLASS FIBER ACOUSTICAL BLANKET INSULATION - MATCH DEPTH OF STUD - UNFACED

07 21 00.30 MINERAL FIBER INSULATION
07 21 00.31 MINERAL FIBER ACOUSTICAL INSULATION - 6 INCH
07 21 00.32 MINERAL FIBER ACOUSTICAL INSULATION - 3 1/2 INCH

07 21 00.39 MINERAL FIBER ACOUSTICAL INSULATION - MATCH DEPTH OF STUD - UNFACED

07 21 00.40 FOAMED IN PLACE INSULATION / AIR BARRIER

07 21 00.50 BACKER ROD AND SEALANT - TYPE AS REQUIRED

07 24 20 EXTERIOR FINISH SYSTEM (EFS)

07 24 20.01 EXTERIOR FINISH - TYPE AND COLOR SELECTED BY ARCHITECT
07 24 20.11 1/2 INCH EXTERIOR GRADE SHEATHING
07 24 20.12 CONTROL JOINT
07 24 20.13 BACKER ROD AND SEALANT - TYPE AS REQUIRED
07 24 20.14 ALUMINUM SOFFIT VENT

07 26 00 VAPOR RETARDERS

07 26 00.01 VAPOR RETARDER - UNDER SLAB
07 26 00.02 FOAMED-IN-PLACE INSULATION WITH BACKER ROD AS REQUIRED
07 26 00.03 VAPOR RETARDER - UNDER STAGE FLOORING
07 26 00.04 VAPOR RETARDER - TAPE SEAMS

07 27 13 MODIFIED BITUMINOUS SHEET AIR BARRIER

07 27 13.01 AIR/VAPOR BARRIER MEMBRANE - SELF-ADHERING
07 27 13.02 AIR/VAPOR BARRIER MEMBRANE - SELF-ADHERING - 2 LAYERS

07 27 13.05 AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING

07 27 13.10 WATERPROOF MEMBRANE FLASHING

07 27 13.20 ALUMINUM FLASHING
07 27 13.21 FASTENER

07 27 33 SPRAYED FOAM INSULATING

07 27 33.02 FOAM INSULATION - SPRAYED-IN-PLACE - 1-1/2 INCH DEPTH BETWEEN STUDS

07 46 46 MINERAL FIBER CEMENT SIDING

07 46 46.01 MINERAL FIBER CEMENT SIDING PANEL
07 46 46.02 MINERAL FIBER CEMENT SMOOTH PANEL

07 46 46.11 STARTER TRACK
07 46 46.12 CLIP
07 46 46.13 SPACER

07 46 46.21 FLASHING
07 46 46.22 SEALANT

07 46 46.31 OPEN OUTSIDE CORNER TRIM
07 46 46.32 FIBER CEMENT OUTSIDE CORNER
07 46 46.33 SINGLE FLANGE SEALANT BACKER
07 46 46.34 DOUBLE FLANGE SEALANT BACKER

07 54 19 POLYVINYL CHLORIDE (PVC) ROOFING

07 54 19.01 PVC SINGLE PLY MEMBRANE ROOFING
07 54 19.02 HIGH DENSITY POLYISO RECOVERY BOARD
07 54 19.03 POLYISO RIGID INSULATION
07 54 19.04 POLYISO TAPERED INSULATION
07 54 19.05 FLASHING MEMBRANE
07 54 19.06 COATED METAL FLASHING
07 54 19.07 ROOFING BATTENS
07 54 19.08 CANT STRIPS
07 54 19.09 SHEET VAPOR RETARDER - TAPE SEAMS

07 54 19.10 FLAT SECUREMENT BARS
07 54 19.11 WIND UPLIFT SECUREMENT BARS
07 54 19.12 BLIND NAILER
07 54 19.13 MULTI-PURPOSE TAPE

07 54 19.20 PVC EXPANSION JOINT
07 54 19.21 FOAM ROD TUBING - CONTINUOUS

07 54 19.80 WALKWAY PADS
07 54 19.81 ROOF EDGE SCUPPER

07 54 19.90 ADHESIVE
07 54 19.91 SEALANT - CONTINUOUS

07 62 00 SHEET METAL FLASHING AND TRIM

07 62 00.01 SHEET METAL FLASHING
07 62 00.02 SHEET METAL COUNTER FLASHING
07 62 00.03 SPRING LOCK FLASHING
07 62 00.04 FLASHING REGLET

07 62 00.10 METAL COPING
07 62 00.11 PRE-FINISHED ALUMINUM FLASHING - CUSTOM COLOR

07 62 00.20 SEALANT - TYPE AS REQUIRED

07 71 00 ROOF SPECIALTIES

07 71 00.01 FACTORY FABRICATED FASCIA TRIM/ROOF EDGE - CUSTOM COLOR
07 71 00.02 EXPOSED ALUMINUM FINISH METAL - CUSTOM COLOR
07 71 00.03 ALUMINUM DRIP EDGE - CUSTOM COLOR
07 71 00.04 FACTORY FABRICATED PARAPET WALL COPING - CUSTOM COLOR

07 71 00.10 SOFFIT STRIP VENT

07 71 00.20 CONTINUOUS SEALANT - TYPE AS REQUIRED

07 72 00 ROOF ACCESSORIES

07 72 00.01 ROOF SCUTTLE - TYPE 1 - 3'-0" x 3'-0"
07 72 00.02 ROOF SCUTTLE - TYPE 2 - 3'-0" x 4'-6"

07 72 00.10 NEOPRENE GASKET ENTIRE PERIMETER TYP.
07 72 00.11 RIGID INSULATION
07 72 00.12 SPRING LATCH W/ HANDLE AND PADLOCK HASP ON INSIDE
07 72 00.13 PADLOCK HASP

07 72 00.20 ELEVATOR ROOFTOP LOUVER

07 72 00.30 12 GA. ALUM. ROOF W/ INSULATION
07 72 00.31 STORM PROOF LOUVER BLADE (THREE SIDES)
07 72 00.32 INSECT SCREEN
07 72 00.33 GLASS WINDOW
07 72 00.34 RUBBER GASKET
07 72 00.35 RIGID INSULATION

07 72 00.40 WELDED ALUMINUM CURB

07 72 00.60 HEAT AND SMOKE VENT - 5'-6" x 12'-0"

07 81 00 APPLIED FIREPROOFING

07 81 00.01 CEMENTITIOUS FIREPROOFING

07 84 00 FIRE STOPPING

07 84 00.01 FIRE SAFING MINERAL WOOL
07 84 00.02 CAULK - CAULK AND PUTTY
07 84 00.03 FIRE STOP MORTAR
07 84 00.04 FIRE STOP PILLOWS
07 84 00.05 INTUMESCENT CAULK WITH URETHANE BACKING ROD

07 84 00.10 INSULATION HANGER SYSTEM
07 84 00.11 CURTAIN WALL INSULATION
07 84 00.12 VERTICAL MULLION COVER
07 84 00.13 SAFING INSULATION
07 84 00.14 SMOKE SEALANT

07 92 00 JOINT SEALERS

07 92 00.01 JOINT SEALANT - TYPE AS REQUIRED
07 92 00.02 BACKER ROD AND SEALANT - TYPE AS REQUIRED
07 92 00.03 BACKER ROD - TYPE AS REQUIRED
07 92 00.11 EXTERIOR EXPANSION JOINT - 4 INCH

07 95 13 CONSTRUCTION AND EXPANSION JOINTS

07 95 13.01 EXPANSION JOINT COVER - 4 INCH - INTERIOR - FLOOR / FLOOR
07 95 13.02 EXPANSION JOINT COVER - 4 INCH - INTERIOR - WALL / WALL - MASONRY
07 95 13.03 EXPANSION JOINT COVER - 4 INCH - INTERIOR - WALL / WALL OR CEILING / CEILING - GYPSUM BASE
07 95 13.04 EXPANSION JOINT COVER - 4 INCH - INTERIOR - WALL / WALL CORNER - GYPSUM BASE
07 95 13.05 EXPANSION JOINT COVER - 4 INCH - INTERIOR - FLOOR / WALL
07 95 13.06 EXPANSION JOINT COVER - 4 INCH - INTERIOR - WALL/WALL - GYPSUM BASE
07 95 13.07 EXPANSION JOINT COVER - 4 INCH - INTERIOR - ACT/WALL

DIVISION 08 - DOORS AND HARDWARE

08 11 13 HOLLOW METAL DOORS AND FRAMES

08 11 13.01 DOOR AND FRAME- SEE DOOR SCHEDULE
08 11 13.10 STEEL DOOR - SEE SCHEDULE FOR TYPES
08 11 13.11 STEEL FRAME - SEE SCHEDULE FOR TYPES
08 11 13.20 STEEL FRAME CLIP BY FRAME INSTALLER
08 11 13.21 STEEL FRAME ANCHOR
08 11 13.30 3/4" x 3/4" GLAZING STOP

08 14 16 FLUSH WOOD DOORS

08 14 16.01 SOLID CORE FLUSH WOOD DOOR- SEE DOOR SCHEDULE

08 31 00 ACCESS DOORS AND PANELS

08 31 00.01 FIRE RATED ACCESS DOOR

08 31 00.11 ACCESS PANEL
08 31 00.12 ACCESS PANEL - FIRE RATED

08 33 13 COILING COUNTER DOORS

08 33 13.01 TYPE 1 - INTERIOR - 4'-6"H x 4'-0"W - MANUALLY OPERATED
08 33 13.02 TYPE 2 - INTERIOR - 4'-0"H x 3'-6"W - MANUALLY OPERATED - HARDWOOD FINISH

08 33 13.21 VERTICAL GUIDES
08 33 13.31 COILING DOOR HOUSING

08 33 26 OVERHEAD COILING GRILLES

08 33 26.01 OVERHEAD COILING GRILLE - TYPE 1 - 7'-0"W x 8'-4"H
08 33 26.02 OVERHEAD COILING GRILLE - TYPE 2 - 14'-0"W x 8'-4"H
08 33 26.03 OVERHEAD COILING GRILLE - TYPE 3 - 6'-0"W x 8'-4"H

08 33 26.05 OVERHEAD COILING EMERGENCY RESPONSE SECURITY GRILLE - TYPE 1 - 11'-1"W x 22'-0"H

08 33 26.11 ELECTRIC MOTOR
08 33 26.12 GUIDE

08 34 73	**SOUND CONTROL DOORS**
08 34 73.01	ACOUSTIC FLUSH WOOD DOOR - SEE DOOR SCHEDULE
08 43 13	**ALUMINUM FRAMED STOREFRONTS**
08 43 13.01	ALUMINUM STOREFRONT FRAME
08 43 13.02	ALUMINUM STOREFRONT DOOR
08 43 13.03	PREFINISHED ALUMINUM FLASHING
08 43 13.04	BEAD OF SEALANT- CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 43 13.20	SEALANT & BACKER ROD
08 43 13.21	CLEAR SILICONE BUTT JOINT - 3/8 INCH
08 44 13	**GLAZED ALUMINUM CURTAIN WALL**
08 44 13.01	ALUMINUM CURTAIN WALL FRAME
08 44 13.02	SLOTTED BRACE CONNECTION - WELD TO TUBE STEEL
08 44 13.03	PREFINISHED ALUMINUM FLASHING
08 44 13.04	BEAD OF SEALANT- CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 44 13.05	PERIMETER SEALANT
08 44 13.11	SNAP COVER - TYPE 1
08 44 13.20	SEALANT & BACKER ROD
08 44 13.30	SPANDREL GLASS
08 44 13.31	INSULATED PANEL
08 44 13.32	PROJECTED WINDOW
08 44 13.50	ALUMINUM BREAK METAL - 0.090 THICK MIN - CUSTOM COLOR TO MATCH CURTAIN WALL FRAMING
08 44 13.51	CONTINUOUS CLIP ANGLE
08 44 13.52	STRUCTURAL TAPE AND SEALANT
08 51 13	**ALUMINUM WINDOWS**
08 51 13.01	ALUMINUM WINDOW - SEE SCHEDULE
08 51 13.02	PERIMETER SEALANT
08 51 13.03	PREFINISHED ALUMINUM FLASHING
08 51 13.04	BEAD OF SEALANT - CONTINUOUS - SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 51 13.05	2x4 ALUMINUM STRUCTURAL TUBE
08 51 13.06	CONTINUOUS SEALANT
08 51 13.07	SPRAY FOAM INSULATION AND BACKER ROD - FILL VOID IN FRAME
08 51 13.08	AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING
08 51 13.09	MINERAL FIBER INSULATION
08 51 13.20	SPANDREL GLASS
08 51 13.31	SNAP TRIM - ALUMINUM - PROFILE TO MATCH GRAHAM WINDOWS PROFILE #17 STEPPED
08 51 13.32	ZERO MULL
08 51 13.33	STACK MULL
08 51 13.34	3 PIECE MULL
08 71 00	**DOOR HARDWARE**
08 71 00.01	SEE DOOR SCHEDULE AND SPECIFICATION FOR HARDWARE
08 71 00.11	ALUMINUM THRESHOLD
08 71 00.21	COAT HOOK
08 80 00	**GLAZING**
08 80 00.01	GLASS TYPE 1
08 80 00.02	GLASS TYPE 2
08 80 00.03	GLASS TYPE 3
08 80 00.04	GLASS TYPE 4
08 80 00.05	GLASS TYPE 5
08 80 00.06	GLASS TYPE 6
08 80 00.07	GLASS TYPE 7
08 80 00.08	GLASS TYPE 8
08 87 00	**GLAZING SURFACE FILM**
08 87 00.01	GLAZING SURFACE FILM TYPE 1
08 90 00	**LOUVERS AND VENTS**
08 90 00.20	ALUMINUM LOUVER - SEE ELEVATIONS AND SPECIFICATION
08 90 00.21	BIRD SCREEN
08 90 00.22	BLANK OFF PANEL
08 90 00.31	SEALANT - TYPE AS REQUIRED
08 92 00	**LOUVERED EQUIPMENT ENCLOSURES**
08 92 00.01	LOUVERED EQUIPMENT ENCLOSURE
08 92 00.11	SCREEN BLADE
08 92 00.12	CLIP ANGLE

08 92 00.13 CONTINUOUS SUPPORT

DIVISION 09 - FINISHES

09 21 23 SHAFT WALL ASSEMBLIES

09 21 23.01 SHAFT ENCLOSURE - 2 HR RATING
09 21 23.04 HORIZONTAL SHAFT ENCLOSURE - 2 HR RATING
09 21 23.11 METAL SHAFTWALL C-H STUD - 2 1/2 INCH - 24 INCHES O.C. MAX
09 21 23.21 GYPSUM SHAFTWALL LINER PANEL - 1 INCH
09 21 23.31 GYPSUM BOARD - 5/8 INCH TYPE "X" - 1 LAYER
09 21 23.32 GYPSUM BOARD - 5/8 INCH TYPE "X" - 2 LAYERS

09 22 16 NON-STRUCTURAL METAL SUPPORT ASSEMBLIES

09 22 16.01 METAL STUD 1-5/8 INCH - 16 INCHES O.C. MAX
09 22 16.02 METAL STUD 2-1/2 INCH - 16 INCHES O.C. MAX
09 22 16.03 METAL STUD 3-5/8 INCH - 16 INCHES O.C. MAX
09 22 16.04 METAL STUD 4 INCH - 16 INCHES O.C. MAX
09 22 16.06 METAL STUD 6 INCH - 16 INCHES O.C. MAX
09 22 16.08 METAL STUD 8 INCH - 16 INCHES O.C. MAX
09 22 16.10 METAL STUD 10 INCH - 16 INCHES O.C. MAX

09 22 16.20 METAL STUD - REFER TO FLOOR PLANS FOR DEPTH
09 22 16.21 METAL FURRING CHANNEL - 7/8 INCH - 16 INCHES O.C. MAX

09 22 16.31 BOXED HEADER

09 22 16.41 METAL DEFLECTION TRACK ASSEMBLY
09 22 16.42 METAL DEFLECTION TRACK ASSEMBLY - FIRE RATED

09 22 16.51 METAL STUD BRACE
09 22 16.52 DOUBLE STUD JAMB - SIZE AS REQUIRED

09 22 16.91 STEEL PLATE - 20 GA. - SECURE TO EACH STUD
09 22 16.99 METAL CLIP FOR WALL FRAMING - 16 GA. - 24 INCHES O.C. MAX

09 29 00 GYPSUM BOARD

09 29 00.01 5/8 INCH GYPSUM BOARD - LEVEL 4 FINISH
09 29 00.02 5/8 INCH GYPSUM BOARD - 2 LAYERS - LEVEL 4 FINISH
09 29 00.03 5/8 INCH GYPSUM BOARD - 1 LAYER EACH SIDE - LEVEL 4 FINISH
09 29 00.04 5/8 INCH GYPSUM BOARD - 2 LAYERS EACH SIDE- LEVEL 4 FINISH
09 29 00.05 5/8 INCH GYPSUM BOARD - LEVEL 5 FINISH
09 29 00.09 1/2 INCH PLYWOOD - FIRE RETARDANT TREATED

09 29 00.21 5/8 INCH GYPSUM BOARD - SAG-RESISTANT - LEVEL 4 FINISH
09 29 00.22 5/8 INCH GYPSUM BOARD - MOISTURE-RESISTANT - LEVEL 4 FINISH

09 29 00.31 5/8 INCH GYPSUM BOARD - IMPACT RESISTANT - LEVEL 4 FINISH
09 29 00.32 5/8 INCH GYPSUM BOARD - ABUSE RESISTANT - LEVEL 4 FINISH

09 29 00.41 CONTROL JOINT - 1/4 INCH
09 29 00.42 REVEAL - PAINTABLE 3/4 INCH
09 29 00.43 METAL MOLDING - CORNER BEAD
09 29 00.44 METAL MOLDING - "J" SHAPE

09 29 00.51 ALUMINUM REVEAL TRIM - SATIN FINISH - 1 INCH
09 29 00.52 ALUMINUM CORNER TRIM - SATIN FINISH - 1-1/8 INCH

09 29 00.99 GYPSUM BOARD SYSTEM - LEVEL 4 FINISH - REFER TO FLOOR PLANS AND WALL TYPES FOR COMPONENTS

09 30 13 CERAMIC TILING

09 30 13.01 CERAMIC MOSAIC FLOOR TILE
09 30 13.02 CERAMIC TILE BASE
09 30 13.11 GLAZED CERAMIC WALL TILE
09 30 13.12 GLAZED CERAMIC WALL TILE CAP
09 30 13.13 GLAZED CERAMIC WALL TILE COVE BASE
09 30 13.31 MARBLE THRESHOLD
09 30 13.41 THIN SET TILE SETTING BED - ON GRADE
09 30 13.42 THIN SET TILE SETTING BED - ON DECK
09 30 13.43 THICK SET TILE SETTING BED
09 30 13.51 CEMENTITIOUS BACKING BOARD

09 30 16 QUARRY TILING

09 30 16.01 QUARRY TILE
09 30 16.02 QUARRY TILE BASE
09 30 16.31 ALUMINUM TRANSITION STRIP
09 30 16.41 THICK SET TILE SETTING BED

09 30 19 PAVER TILING

09 30 19.01 PORCELAIN FLOOR TILE
09 30 19.02 PORCELAIN WALL TILE
09 30 19.11 PORCELAIN TILE BASE - 6" x 12"

09 30 19.12	PORCELAIN BULLNOSE TILE - 4" x 24"
09 30 19.31	PORCELAIN WALL TILE - 6" x 24"
09 30 19.32	PORCELAIN WALL TILE - 6" x 6"
09 30 19.33	PORCELAIN WALL TILE - 12" x 24"
09 30 19.34	PORCELAIN WALL TILE - 24" x 24"
09 30 19.41	THIN SET TILE SETTING BED
09 30 19.51	CEMENTITIOUS BACKING BOARD
09 30 19.61	ALUMINUM CORNER TRIM
09 51 00	**ACOUSTICAL CEILINGS**
09 51 00.01	ACT TYPE-1
09 51 00.02	ACT TYPE-2
09 51 00.03	ACT TYPE-3
09 51 00.04	ACT TYPE-4
09 51 00.05	ACT TYPE-5
09 51 00.06	ACT TYPE-6
09 51 00.51	ACT SUSPENSION SYSTEM
09 51 00.52	PERIMETER EDGE TRIM SYSTEM
09 51 00.53	RETENTION CLIPS
09 51 00.97	ACOUSTICAL CLOUD - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT
09 51 00.98	WOOD VENEER CEILING SYSTEM - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT
09 51 00.99	ACOUSTICAL CEILING - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT
09 64 29	**WOOD STRIP AND PLANK FLOORING**
09 64 29.01	WOOD STRIP AND PLANK FLOOR
09 64 29.11	HARDWOOD TRIM - 1" x 8" WITH BULLNOSE
09 64 29.12	WOOD BLOCKING - SIZE AS REQUIRED
09 64 29.21	PLYWOOD UNDERLAYMENT - 5/8 INCH
09 64 29.22	SLEEPERS AND SHIMS
09 64 29.23	VAPOR RETARDER
09 64 66	**WOOD ATHLETIC FLOORING**
09 64 66.01	WOOD ATHLETIC FLOOR
09 64 66.02	RUBBER COVE WALL BASE - VENTED
09 64 66.05	GAME LINES - COURT MARKINGS - PAINTED
09 64 66.06	LOGO - PAINTED
09 64 66.07	STENCIL LETTERING - PAINTED
09 65 13	**RESILIENT BASE AND ACCESSORIES**
09 65 13.01	RUBBER BASE - 4"
09 65 13.02	RUBBER BASE - 2"
09 65 16	**RESILIENT SHEET FLOORING**
09 65 16.01	RESILIENT SHEET VINYL FLOORING
09 65 16.11	TRANSITION STRIP
09 65 19	**RESILIENT TILE FLOORING**
09 65 19.01	VINYL COMPOSITION TILE
09 65 19.11	TRANSITION STRIP
09 65 23	**RUBBER FLOORING**
09 65 23.01	RUBBER FLOOR TILE - RAISED STUD PROFILE - STAIR TREADS/RISERS AND LANDINGS
09 65 23.02	RUBBER FLOOR TILE - HAMMERED PROFILE
09 65 23.03	RUBBER FLOOR TILE - ATHLETIC
09 65 23.11	TRANSITION STRIP
09 65 36	**STATIC-CONTROL RESILIENT FLOORING**
09 65 36.01	STATIC-CONTROL COMPOSITE TILE
09 65 43	**LINOLEUM FLOORING**
09 65 43.01	LINOLEUM SHEET FLOORING
09 65 43.11	TRANSITION STRIP
09 68 00	**CARPETING**
09 68 00.01	CARPET
09 68 00.02	CARPET BORDER
09 68 00.11	RUBBER CARPET REDUCING STRIP
09 68 00.12	METAL CARPET REDUCING STRIP
09 68 00.13	VINYL STAIR NOSING
09 68 00.14	BOUND EDGING
09 68 00.15	RUBBER STAIR TREAD NOSING
09 72 00	**WALL COVERINGS**
09 72 00.01	VINYL WALL COVERING

09 84 00 ACOUSTICAL ROOM COMPONENTS

09 84 00.01 ACOUSTICAL PANEL - WALL MOUNTED - TYPE 1
09 84 00.02 ACOUSTICAL PANEL - WALL MOUNTED - TYPE 2
09 84 00.03 ACOUSTICAL PANEL - WALL MOUNTED - TYPE 3
09 84 00.04 ACOUSTICAL PANEL - WALL MOUNTED - TYPE 4
09 84 00.05 ACOUSTICAL PYRAMID PANEL - CEILING MOUNTED - TYPE 5
09 84 00.06 ACOUSTICAL PANEL - CEILING HUNG - TYPE 6

09 84 00.99 CONCEALED "Z" CLIP MOUNTING SYSTEM

09 91 00 PAINTING

09 91 00.01 PAINT - SEE SCHEDULE
09 91 00.10 DRY ERASE PAINT
09 91 00.12 METALLIC PAINT

09 96 00 HIGH-PERFORMANCE COATINGS

09 96 00.01 HIGH PERFORMANCE COATING

DIVISION 10 - SPECIALTIES

10 11 16 MARKER BOARDS

10 11 16.01 DRY MARKER BOARD
10 11 16.02 DRY MARKER BOARD / TACK BOARD
10 11 16.03 MENU BOARD
10 11 16.04 VERTICAL SLIDING MARKER BOARD

10 11 16.11 TACK BOARD
10 11 16.12 2 INCH TACK BOARD STRIP
10 11 16.19 TACK BOARD WALL

10 11 16.31 SILK SCREEN - MUSIC STAFF LINING

10 11 16.41 OMIT MARKER TRAY FROM MARKER BOARD

10 12 00 DISPLAY CASES

10 12 00.01 DISPLAY CASE - TYPE 1
10 12 00.02 DISPLAY CASE - TYPE 2
10 12 00.03 DISPLAY CASE - TYPE 3
10 12 00.04 DISPLAY CASE - TYPE 4
10 12 00.05 DISPLAY CASE - TYPE 5

10 14 00 SIGNAGE

10 14 00.01 INTERIOR SIGNAGE - TYPE AS SCHEDULED
10 14 00.02 INTERIOR SIGNAGE - METAL LETTERS

10 14 00.10 STANDOFF HARDWARE

10 14 00.21 ALUMINUM EXTERIOR SIGN - TWO SIDED
10 14 00.23 EXTERIOR SIGNAGE - TYPE AS SCHEDULED

10 14 00.30 WALL MOUNTING BRACKET
10 14 00.31 EXPANSION BOLT

10 14 00.40 FABRIC BANNER - INTERIOR
10 14 00.41 FABRIC BANNER - EXTERIOR

10 21 13 TOILET COMPARTMENTS

10 21 13.01 TOILET COMPARTMENT
10 21 13.11 TOILET PARTITION - PANEL
10 21 13.12 TOILET PARTITION - POST - FLOOR TO CEILING
10 21 13.13 TOILET PARTITION - WALL BRACKET
10 21 13.21 TOILET COMPARTMENT DOOR - 36 INCH
10 21 13.22 TOILET COMPARTMENT DOOR - 28 INCH
10 21 13.31 URINAL SCREEN
10 21 13.41 PRIVACY PARTITION - 30 INCHES WIDE x 48 INCHES TALL - MOUNT 24 INCHES ABOVE FINISH FLOOR

10 22 28 FOLDING PANEL PARTITIONS

10 22 28.01 FOLDING PANEL PARTITION
10 22 28.02 FOLDING PANEL PARTITION DOOR
10 22 28.03 FOLDING PANEL PARTITION MARKERBOARD

10 22 28.11 MOTORIZED FOLDING PANEL PARTITION

10 28 13 TOILET ACCESSORIES

10 28 13.01 TOILET ACCESSORY - SEE SCHEDULE

10 28 13.10 COAT HOOK
10 28 13.11 PAPER TOWEL DISPENSER

10 28 13.12 SOAP DISPENSER
10 28 13.13 HAND SANITIZER DISPENSER
10 28 13.14 BABY CHANGING STATION

10 44 00 FIRE PROTECTION SPECIALTIES

10 44 00.01 FIRE EXTINGUISHER CABINET - FULLY RECESSED
10 44 00.02 FIRE EXTINGUISHER AND BLANKET CABINET - FULLY RECESSED
10 44 00.03 FIRE EXTINGUISHER WALL MOUNTED BRACKET

10 44 00.11 FIRE EXTINGUISHER
10 44 00.12 FIRE BLANKET

10 44 00.21 EMERGENCY KEY CABINET

10 44 00.31 FIRST AID KIT - WALL MOUNTED

10 51 13 METAL LOCKERS

10 51 13.01 METAL LOCKER - SLOPED TOP - TYPE 1
10 51 13.02 METAL LOCKER - SLOPED TOP - TYPE 2
10 51 13.03 METAL LOCKER - SLOPED TOP - TYPE 3
10 51 13.04 METAL LOCKER - SLOPED TOP - TYPE 4

10 51 13.10 METAL FILLER PANEL - EACH SIDE OF LOCKER BANK TO CENTER LOCKERS IN OPENING
10 51 13.11 LOCKER ROOM BENCH
10 51 13.13 LOCKER TRIM

10 71 13 EXTERIOR SUN CONTROL DEVICES

10 71 13.01 ALUMINUM SUNSHADE ASSEMBLY

10 71 13.10 ALUMINUM SUNSHADE OUTRIGGER
10 71 13.11 ALUMINUM SUNSHADE KNIFE PLATE
10 71 13.12 ALUMINUM SUNSHADE BRACKET
10 71 13.13 ALUMINUM SUNSHADE FASCIA
10 71 13.14 ALUMINUM SUNSHADE BLADE - 1 1/2" DIAMETER
10 71 13.15 ALUMINUM SUNSHADE BLADE - 2 1/2" DIAMETER
10 71 13.16 ALUMINUM MESH - PATTERN CHOSEN BY ARCHITECT
10 71 13.17 ALUMINUM SUNSHADE SUPPORT ROD
10 71 13.18 ALUMINUM SUNSHADE TURNBUCKLE

10 71 13.99 SEALANT - TYPE AS REQUIRED

DIVISION 11 - EQUIPMENT

11 31 00 RESIDENTIAL APPLIANCES

11 31 00.01 REFRIGERATOR
11 31 00.02 REFRIGERATOR - UNDER-COUNTER
11 31 00.03 REFRIGERATOR/FREEZER - UNDER-COUNTER
11 31 00.04 PASS THRU COOLER - COUNTERTOP

11 31 00.11 DISHWASHER - UNDER-COUNTER

11 31 00.21 WASHER
11 31 00.22 DRYER
11 31 00.23 STORAGE DRAWER PEDESTAL

11 31 00.25 HEAVY-DUTY WASHER
11 31 00.26 HEAVY-DUTY DRYER

11 31 00.31 ICE MACHINE - UNDER-COUNTER
11 31 00.32 ICE MACHINE
11 31 00.33 ICE MACHINE - COUNTERTOP

11 31 00.41 WALL OVEN - BUILT-IN - ELECTRIC
11 31 00.42 IN COUNTER COOKTOP - ELECTRIC
11 31 00.43 SLIDE IN RANGE - ELECTRIC
11 31 00.44 RANGE HOOD

11 40 00 FOODSERVICE EQUIPMENT

11 40 00.01 FOODSERVICE EQUIPMENT - SEE FOODSERVICE SPECIFICATION AND DRAWINGS

11 40 00.11 EXHAUST VENTILATOR - REFER TO FOODSERVICE EQUIPMENT DRAWINGS AND SPECIFICATIONS
11 40 00.12 CLOSURE PANEL BY KITCHEN EQUIPMENT CONTRACTOR

11 40 00.21 STAINLESS STEEL MOBILE PREP TABLE - 4'-0" x 6'-0"

11 52 13 PROJECTION SCREENS

11 52 13.01 PROJECTION SCREEN - TYPE 1
11 52 13.02 PROJECTION SCREEN - TYPE 2
11 52 13.03 PROJECTION SCREEN - TYPE 3
11 52 13.04 PROJECTION SCREEN - TYPE 4

11 52 13.10	PROJECTOR LIFT
11 53 00	**LABORATORY EQUIPMENT**
11 53 00.01	GOGGLE CABINET
11 53 00.02	MICROSCOPE CABINET
11 53 00.15	ACID STORAGE CABINET - TYPE 1
11 53 00.16	ACID STORAGE CABINET - TYPE 2
11 53 00.18	FLAMMABLE STORAGE CABINET - TYPE 1
11 53 00.21	WATER DISTILLER
11 53 00.31	AUTOCLAVE STERILIZER
11 53 00.41	INCUBATOR
11 53 00.51	DECK MOUNTED EYEWASH
11 53 00.52	GLASSWARE PEGBOARD @ SUPPORT BRACKETS
11 53 13	**LABORATORY FUME HOODS**
11 53 13.01	FUME HOOD
11 53 13.10	SERVICE AND WATER FITTINGS
11 61 00	**THEATER AND STAGE EQUIPMENT**
11 61 00.01	DIMMING RACK
11 61 00.02	DIMMING CONSOLE
11 61 00.03	LIGHTING CONSOLE
11 61 00.04	STAGE MANAGER PANEL
11 61 00.05	TORM LADDER
11 61 00.06	STAGE RIGGING
11 61 00.07	CURTAIN - MAIN VALANCE
11 61 00.08	CURTAIN - MAIN TRAVELER
11 61 00.09	CURTAIN - BORDER
11 61 00.10	CURTAIN - LEG
11 61 00.11	CURTAIN - TRAVELER
11 61 00.12	CURTAIN - CYCLORAMA
11 61 00.13	CURTAIN - SIDE TABS
11 61 00.22	STEEL ANGLES WITH PRE-PUNCHED HOLES - SIZE AND GAGE AS REQUIRED
11 61 00.23	STAINLESS STEEL ROD - 3/16 INCH DIAMETER
11 61 00.24	STAINLESS STEEL BOLT AND WASHERS
11 66 23	**GYMNASIUM EQUIPMENT**
11 66 23.01	WALL PADDING - TYPE 1
11 66 23.02	WALL PADDING - TYPE 2
11 66 23.03	WALL PADDING - TYPE 3
11 66 23.11	VOLLEYBALL STANDARD FLOOR INSERT
11 66 23.21	MAT HOIST - TYPE 1
11 66 24	**BASKETBALL GYM EQUIPMENT**
11 66 24.01	BACKSTOP - FORWARD FOLDING - ADJUSTABLE CEILING MOUNTED - ELECTRIC OPERATED
11 66 24.02	BACKSTOP - SIDE FOLDING - ADJUSTABLE CEILING MOUNTED - ELECTRIC OPERATED
11 66 24.21	BACKBOARD - GLASS - OFFICIAL 72 x 48 - SAFETY PADDING
11 66 53	**GYMNASIUM DIVIDERS**
11 66 53.01	ROLL-FOLD DIVIDER CURTAIN - OVERHEAD SUPPORTED
11 66 53.11	DIVIDER CURTAIN MOTOR

DIVISION 12 - FURNISHINGS

12 24 00	**WINDOW SHADES**
12 24 00.01	ROLLER SHADE
12 24 00.02	ROLLER SHADE - ELECTRICALLY OPERATED
12 24 00.11	BLACKOUT SHADE
12 24 00.12	BLACKOUT SHADE - ELECTRICALLY OPERATED
12 24 00.21	DUAL ROLLER SHADES
12 30 00	**CASEWORK**
12 30 00.01	BASE CABINET
12 30 00.02	WALL CABINET
12 30 00.03	TALL CABINET
12 30 00.10	LOCKING NARCOTICS CABINET
12 30 00.20	PLASTIC LAMINATE COUNTERTOP
12 30 00.21	PLASTIC LAMINATE BACKSPLASH - 4 INCH

12 30 00.22 PVC EDGE BANDING
12 30 00.23 PLASTIC LAMINATE BACKSPLASH - 6 INCH
12 30 00.24 PLASTIC LAMINATE BACKSPLASH - 8 INCH
12 30 00.25 PLASTIC LAMINATE COUNTERTOP - HIGH WEAR

12 30 00.28 STAINLESS STEEL COUNTERTOP
12 30 00.29 STAINLESS STEEL COUNTERTOP AND BACKSPLASH-SIZE AS NOTED
12 30 00.30 GROMMET - 3 INCH - PLASTIC
12 30 00.31 STEEL UNDER COUNTER SUPPORT BRACKET - SIZE AS NOTED OR DRAWN
12 30 00.32 LOCK

12 30 00.40 APRON HOOKS

12 30 00.50 FILLER PIECE SCRIBED TO ADJACENT SURFACE - FINISH TO MATCH CASEWORK

12 30 00.60 4" WOOD VALANCE-CONTINUOUS - FINISH TO MATCH CASEWORK
12 30 00.61 WOOD END PANEL - FINISH TO MATCH CASEWORK

12 30 00.65 RESIN LABORATORY COUNTERTOP AND BACKSPLASH
12 30 00.66 RESIN LABORATORY SHELF

12 30 00.71 QUARTZ COUNTERTOP AND BACKSPLASH

12 30 00.80 SEALANT

12 30 00.90 FASTENER

12 35 51 MUSICAL INSTRUMENT STORAGE CASEWORK

12 35 51.10 MUSIC LIBRARY STORAGE SYSTEM

12 48 13 ENTRANCE FLOOR MATS AND FRAMES

12 48 13.01 RECESSED ENTRANCE GRATING - REFERENCE DRAWINGS FOR SIZE
12 48 13.02 RECESSED ENTRANCE MAT - REFERENCE DRAWINGS FOR SIZE
12 48 13.05 EXTRUDED ALUMINUM RECESSED FRAMING - Z SHAPE
12 48 13.10 EXTRUDED ALUMINUM RECESSED FRAMING - L SHAPE

12 61 00 FIXED AUDIENCE SEATING

12 61 00.01 FIXED AUDIENCE SEAT
12 61 00.02 FIXED AUDIENCE SEAT WITH LIGHT UNDER ARMREST
12 61 00.03 FIXED AUDIENCE SEAT - ADA ACCESSIBLE ARMLESS SEAT

12 66 13 TELESCOPING BLEACHERS

12 66 13.01 TELESCOPING POWER ASSISTED WOOD BLEACHERS
12 66 13.03 PORTABLE TELESCOPING MANUAL WOOD BLEACHERS

12 66 13.11 END-CLOSURE CURTAINS
12 66 13.12 MEDIA PLATFORM

12 68 00 SEAT AND TABLE ASSEMBLIES

12 68 00.01 FIXED SEATING AND TABLES

DIVISION 13 - SPECIAL CONSTRUCTION

13 00 00 NOT USED

13 00 00.01 NOT USED

DIVISION 14 - CONVEYING SYSTEM

14 21 23 COMPACT TRACTION ELEVATORS

14 21 23.01 ELEVATOR - TYPE 1 - SEE SPECIFICATION
14 21 23.02 ELEVATOR - TYPE 2 - SEE SPECIFICATION
14 21 23.03 ELEVATOR - TYPE 3 - SEE SPECIFICATION

14 21 23.05 ELEVATOR CONTROLLER

14 21 23.11 ELEVATOR CAB
14 21 23.12 ELEVATOR PLATFORM
14 21 23.13 ELEVATOR SILL
14 21 23.14 ELEVATOR DOOR FRAME
14 21 23.15 ELEVATOR DOORS
14 21 23.16 ELEVATOR DOOR GUIDE
14 21 23.17 ELEVATOR GUIDE RAILS AND BRACKETS
14 21 23.18 ELEVATOR PIT LADDER

14 21 23.21 STEEL SILL GUARDS
14 21 23.22 SHIM

DIVISION 15 - RESERVED

15 00 00 NOT USED

15 00 00.01 NOT USED

DIVISION 16 - RESERVED

16 00 00 NOT USED

16 00 00.01 NOT USED

DIVISION 17 - RESERVED

17 00 00 NOT USED

17 00 00.01 NOT USED

DIVISION 18 - RESERVED

18 00 00 NOT USED

18 00 00.01 NOT USED

DIVISION 19 - RESERVED

19 00 00 NOT USED

19 00 00.01 NOT USED

DIVISION 20 - RESERVED

20 00 00 NOT USED

20 00 00.01 NOT USED

DIVISION 21 - FIRE SUPPRESSION

21 00 00 FIRE SUPPRESSION

21 00 00.01 SPRINKLER HEAD - PENDANT
21 00 00.02 SPRINKLER HEAD - UPRIGHT
21 00 00.03 SPRINKLER HEAD - RECESSED
21 00 00.04 SPRINKLER HEAD - SIDEWALL
21 00 00.05 FIRE STANDPIPE
21 00 00.06 SPRINKLER PIPE
21 00 00.07 FIRE DEPARTMENT VALVE / CABINET
21 00 00.08 FIRE DEPARTMENT VALVE
21 00 00.09 FIRE DEPARTMENT CONNECTION
21 00 00.10 VALVE AND EXTINGUISHER CABINET

DIVISION 22 - PLUMBING

22 00 00 PLUMBING

22 00 00.01 SINK - SEE PLUMBING
22 00 00.02 LAVATORY - SEE PLUMBING
22 00 00.03 WATER FOUNTAIN - SEE PLUMBING
22 00 00.04 ELECTRIC WATER COOLER - SEE PLUMBING
22 00 00.05 WATER CLOSET - SEE PLUMBING
22 00 00.06 URINAL - SEE PLUMBING
22 00 00.07 SHOWER - SEE PLUMBING
22 00 00.08 MOP RECEPTOR - SEE PLUMBING
22 00 00.09 HOSE REEL ASSEMBLY - SEE PLUMBING
22 00 00.10 HOSE BIB - SEE PLUMBING
22 00 00.11 MOP SINK - SEE PLUMBING
22 00 00.12 HYDRATION STATION - SEE PLUMBING
22 00 00.15 COMPRESSED AIR SUPPLY VALVE - SEE PLUMBING
22 00 00.20 ROOF DRAIN ASSEMBLY - SEE PLUMBING
22 00 00.21 FLOOR DRAIN - SEE PLUMBING
22 00 00.22 DRAIN PIPE - SEE PLUMBING
22 00 00.23 AREA DRAIN - SEE PLUMBING
22 00 00.24 TRENCH DRAIN - SEE PLUMBING
22 00 00.30 PIPE INSULATION - SEE PLUMBING
22 00 00.35 RAIN WATER LEADER - SEE PLUMBING
22 00 00.40 FREEZE PROOF WALL HYDRANT - SEE PLUMBING
22 00 00.50 PIPE PENETRATION - SEE PLUMBING
22 00 00.60 PIPE - SEE PLUMBING
22 00 00.70 EMERGENCY EYEWASH/SHOWER STATION
22 00 00.71 EMERGENCY UTILITY CONTROLLER
22 00 00.80 GAS METER - SEE PLUMBING
22 00 00.98 SHOWER HEAD & FAUCET - SEE PLUMBING
22 00 00.99 RESIDENTIAL SHOWER / TUB - SEE PLUMBING

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

23 00 00 HEATING, VENTILATING, AND AIR CONDITIONING

23 00 00.01 CONVECTOR - SEE HVAC
23 00 00.02 DIFFUSER - SEE HVAC
23 00 00.03 CABINET UNIT HEATER - SEE HVAC
23 00 00.04 PTAC UNIT - SEE HVAC
23 00 00.06 ROOF TOP UNIT - SEE HVAC
23 00 00.08 BOILER STACK - SEE HVAC
23 00 00.10 FAN - SEE HVAC
23 00 00.12 EXHAUST FAN UNIT - SEE HVAC
23 00 00.14 VENT - SEE HVAC
23 00 00.20 SUPPLY AIR REGISTER - SEE HVAC
23 00 00.21 RETURN AIR REGISTER - SEE HVAC
23 00 00.22 AIR PLENUM - SEE HVAC
23 00 00.23 DUCT - SEE HVAC
23 00 00.24 FLEXIBLE AIR DUCT - SEE HVAC
23 00 00.25 RADIANT PANEL - SEE HVAC
23 00 00.30 STAINLESS STEEL EXHAUST HOOD -SEE HVAC

DIVISION 24 - RESERVED

24 00 00 NOT USED

24 00 00.01 NOT USED

DIVISION 25 - INTEGRATED AUTOMATION

25 00 00 NOT USED

25 00 00.01 NOT USED

DIVISION 26 - ELECTRICAL

26 00 00 ELECTRICAL

26 00 00.01 LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.02 COVE LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.03 2x4 LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.04 2x2 LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.05 1x4 LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.06 8' LONG PENDANT LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.07 4' LONG PENDANT LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.08 4' INDUSTRIAL LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.09 DOWN LIGHT - SEE ELECTRICAL
26 00 00.10 WALL MOUNTED LIGHT - SEE ELECTRICAL
26 00 00.11 PENDANT LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.12 UNDER-COUNTER LIGHT - SEE ELECTRICAL
26 00 00.13 EXTERIOR LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.14 TV STUDIO "ON AIR" SIGN - SEE ELECTRICAL
26 00 00.15 UNDER SLAB CONDUIT - SEE ELECTRICAL
26 00 00.16 ELECTRICAL CONDUIT - SEE ELECTRICAL
26 00 00.21 CEILING MOUNTED SPEAKER BAFFLE - SEE ELECTRICAL
26 00 00.22 FIRE ALARM ANNUNCIATOR PANEL - SEE ELECTRICAL
26 00 00.23 FIRE ALARM AUDIO/VISUAL UNIT - SEE ELECTRICAL
26 00 00.24 FIRE ALARM PULL - SEE ELECTRICAL
26 00 00.25 EXIT SIGN - SEE ELECTRICAL
26 00 00.26 FIRE ALARM CONTROL PANEL - SEE ELECTRICAL
26 00 00.30 SCOREBOARD - SEE ELECTRICAL
26 00 00.31 SHOT CLOCK - SEE ELECTRICAL
26 00 00.35 DESTRATIFICATION FAN - SEE ELECTRICAL
26 00 00.45 SURFACE MTD JUNCTION BOX AND CONDUIT FOR SOUND SYSTEM - SEE ELECTRICAL
26 00 00.50 ELECTRICAL OUTLET - SEE ELECTRICAL
26 00 00.51 ELECTRICAL FLOOR OUTLET - SEE ELECTRICAL
26 00 00.52 LIGHT SWITCH - SEE ELECTRICAL
26 00 00.53 ELECTRICAL RETRACTABLE OVERHEAD OUTLET - SEE ELECTRICAL
26 00 00.54 ELECTRICAL OUTLET WITH DIRECT CURRENT - SEE ELECTRICAL
26 00 00.60 LCD ANNUNCIATOR - SEE ELECTRICAL
26 00 00.66 SECURITY KEYPAD - SEE ELECTRICAL
26 00 00.67 CARD READER - SEE ELECTRICAL
26 00 00.70 EXTERIOR WALL MOUNTED SPEAKER
26 00 00.72 ELECTRICAL POWER PANELS - SEE ELECTRICAL
26 00 00.75 EMERGENCY LIGHTING
26 00 00.76 SECURITY STROBE
26 00 00.98 EMERGENCY SHUT OFF - SEE ELECTRICAL
26 00 00.99 ELECTRICAL PANEL - SEE ELECTRICAL

DIVISION 27 - COMMUNICATIONS

27 10 00 STRUCTURED CABLING

27 10 00.01 CPU HOLDER - SEE TECHNOLOGY
27 10 00.10 DATA OUTLET - SEE TECHNOLOGY
27 10 00.11 TELEPHONE JACK - SEE TECHNOLOGY - TELEPHONE DEVICE TO BE OWNER FURNISHED AND INSTALLED
27 10 00.21 EQUIPMENT RACK - SEE TECHNOLOGY
27 10 00.22 CABLE TRAY - SEE TECHNOLOGY

27 21 33 DATA COMMUNICATIONS WIRELESS ACCESS POINTS

27 21 33.01 WIRELESS ACCESS POINT - SEE TECHNOLOGY

27 40 00 AUDIO-VIDEO COMMUNICATIONS

27 40 00.01 INTERACTIVE WHITE BOARD - SEE SPECIFICATION
27 40 00.02 CAMERA - SEE TECHNOLOGY
27 40 00.03 VIDEO DISPLAY MONITOR
27 40 00.04 VIDEO DISPLAY WALL BRACKET
27 40 00.06 SPEAKER - SEE TECHNOLOGY
27 40 00.07 EQUIPMENT RACK
27 40 00.08 PROJECTOR - SEE TECHNOLOGY
27 40 00.10 FACE PLATE - SEE TECHNOLOGY

27 50 00 DISTRIBUTED COMMUNICATIONS AND MONITORING

27 50 00.01 SPEAKER - SEE TECHOLOGY
27 50 00.11 CLOCK - SEE TECHNOLOGY

27 70 00 VIDEO DISTRIBUTION SYSTEM

27 70 00.01 TV - FLAT SCREEN - SEE TECHNOLOGY

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 13 00 ACCESS CONTROL

28 13 00.01 NOT USED

28 16 00 INTRUSION DETECTION

28 16 00.01 MOTION SENSOR - SEE TECHNOLOGY

28 23 00 VIDEO SURVEILLANCE

28 23 00.01 CAMERA - SEE TECHNOLOGY

DIVISION 29 - RESERVED

29 00 00 NOT USED

29 00 00.01 NOT USED

DIVISION 30 - RESERVED

30 00 00 NOT USED

30 00 00.01 NOT USED

DIVISION 31 - EARTHWORK

31 00 00 NOT USED

31 00 00.01 NOT USED

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 13 13 SITE CONCRETE

32 13 13.01 SIDEWALK - SEE CIVIL/LANDSCAPE
32 13 13.02 BOND BREAKER

DIVISION 33 - UTILITIES

33 00 00 NOT USED

33 00 00.01 NOT USED

DIVISION 34 - TRANSPORTATION

34 00 00 NOT USED

34 00 00.01 NOT USED

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

35 00 00 NOT USED

35 00 00.01 NOT USED

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